3.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

This chapter describes the baseline conditions of the developed and natural environment potentially affected by the implementation of NASA's proposed ISRP. This chapter establishes a baseline, for evaluating the potential impacts of each of the three action alternatives for the ISRP. The potential impacts are described in *Chapter 4: Environmental Consequences*. A list of the primary documents used in this DEIS is provided in Appendix D. These resource documents are available from NASA EPO for review. Other references are listed as literature cited in the following text and Appendix E.

The following resources are addressed in this review of the affected environment:

3.1 LAND USE
3.2 ATMOSPHERIC ENVIRONMENT
3.3 AMBIENT NOISE
3.4 GEOLOGY AND SOILS
3.5 HYDROLOGY AND WATER QUALITY
3.6 BIOLOGICAL RESOURCES
3.7 SOCIO-ECONOMICS
3.8 CULTURAL RESOURCES

3.1 LAND USE

This section describes general land uses within KSC, the ISRP alternative sites, and the nearby surrounding area.

3.1.1 John F. Kennedy Space Center

Land and open water resources of KSC comprise 56,500 ha (139,490 ac) in Brevard and Volusia counties located along the east coast of central Florida at 28^o 38'N, 80^o 42'W (Breininger *et al.* 1994, Schmalzer and Hinkle 1992, NASA 1997a). The majority of the land areas comprising KSC lie on the northern part of Merritt Island, which forms a barrier island complex with adjacent Cape Canaveral (NASA 1979, Schmalzer and Hinkle 1992). NASA acquired the KSC lands in 1962 (NASA 2002). Undisturbed areas, including uplands, wetlands, mosquito control impoundments, and open water areas, comprise approximately 95 percent of the total KSC area (NASA 2002). Nearly 40 percent of KSC consists of open water areas and includes portions of the Indian River, the Banana River, Mosquito Lagoon and all of Banana Creek (NASA 2002).

KSC was established under NASA jurisdiction for the purpose of implementing the Nation's space program (NASA 1997a). NASA maintains operational control over approximately 1,806 ha (4,463 ac) of KSC. This area comprises the functional area, which is dedicated to NASA operations (NASA 2002). Undeveloped operational areas are dedicated safety zones around existing facilities or are reserved for planned and future expansion.

The overall land use and management objectives of NASA and KSC are to maintain the Nation's space mission operations while supporting alternative land uses that are in the Nation's "best interest" under the Space Act (NASA 2002). Towards these ends, KSC developed a Land Use Plan in 1999 and then participated in the development of the Cape Canaveral Spaceport Master Plan in cooperation with the 45th Space Wing and the Florida Space Authority. These plans provide a general context for future land use decisions. They provide an overall context for future land uses on KSC while not identifying any specific facility or land development projects. Such future projects will be driven by program changes and management decisions as yet undefined.

The designation of the MINWR and Canaveral National Seashore (CNS), in 1963 and 1975 respectively, on the 54,851 ha (135,537 ac) outside of NASA's operational control reflects this "best interest" objective. Both the MINWR and CNS effectively provide a buffer zone between NASA operations and the surrounding communities (see Figure 1-1). NASA delegated land management responsibilities for the MINWR to the USFWS and for the CNS to the National Park Service (NPS). The NPS administers a 2,693 ha (6,655 ac) area of the total 23,310 ha (57,600 ac) CNS, while the USFWS administers 20,617 ha (50,945 ac) of CNS and 38,258 ha (94,537 ac) of MINWR (NASA 2002). The USFWS and NPS exercise management control over agricultural, recreational, and environmental programs within their respective jurisdictions at KSC (NASA 2002). NASA remains the landowner and maintains the option to remove lands from the MINWR or CNS as needed to support the space program (NASA and USFWS 2002, Edward E. Clark 1985). NASA, working in partnership with the USFWS and NPS, has demonstrated that through careful land planning and management the requirements of space flight and protection of natural resources can be achieved with minimal conflict (NASA 2002).

3.1.1.1 Alternative 1

The ISRP, under Alternative 1 (Phases A-F) would be located on approximately 128 ha (316 ac) to the west side of Space Commerce Way (Figure 1-2). This site is currently undeveloped, and is composed primarily of citrus groves. The general KSC land use class for these lands is agriculture. Management of the lands is the responsibility of the USFWS. Under a Memorandum of Understanding (MOU) with USFWS, a portion of the citrus groves on the site is leased to the Kerr Center for Sustainable Agriculture (Kerr & USFWS 1998) for citrus production through 2008. For development of the ISRP, NASA will remove land from MINWR in phases and transfer land management responsibilities from USFWS to the ISRPA.

3.1.1.2 Alternative 2

The ISRP, under Alternative 2 (Phases A-F) would be located on approximately 130 ha (321 ac) to the east of SR 3, approximately 1.6 km (1 mi) south of Space Commerce Way at B Ave SW (or Tel-4 Road) (Figure 1-2). The undeveloped site is characterized by a scrubby pine flatwoods matrix with slightly elevated oak scrub ridges and numerous freshwater wetland swales oriented north–to–south. The majority of Alternative 2 is undisturbed and represents well-managed, high quality habitat. The land in this alternative would be removed from the MINWR for development as the ISRP. NASA would transfer land management responsibility from MINWR to the ISRPA.

3.1.1.3 Phase F

The Phase F parcel, common to both Alternative 1 and Alternative 2, consists of approximately 10 ha (24 ac) located east of the Space Commerce Way and adjoining the existing SERPL development site (Figure 1-2). This undeveloped site is predominantly citrus groves, and has already been removed from MINWR, making it KSC operational land.

3.1.2 Surrounding Land Use

Major municipalities in the vicinity of KSC include the City of Titusville, located on the mainland approximately 11 km (7 mi) west of the ISRP alternative site locations, and the City of Cape Canaveral, located approximately 22 km (14 mi) southeast of the alternative locations proposed for the ISRP. The unincorporated community of Merritt Island adjoins the southern boundaries of KSC and is approximately 1.6 km (1 mi) from Alternative 2. Land use on Merritt Island is primarily agriculture and rural residential. Brevard County has zoned the SR 3 corridor, south of KSC, agriculture, rural residential, and industry. Agriculture is dominated by citrus groves. Industry in this area is limited to a liquid nitrogen gas manufacturing plant adjacent to KSC property fronting SR 3. This plant is a strategic facility for KSC. The nitrogen is piped directly to KSC where it is used for purging equipment.

3.2 ATMOSPHERIC ENVIRONMENT

3.2.1 Climate

The climate of KSC is subtropical with hot, humid summers and short, mild and dry winters. The main factors influencing climate at KSC are latitude and proximity to the Atlantic Ocean and the Indian River Lagoon (IRL) system, which moderate temperature fluctuations (NASA 2002). Summer weather, usually beginning in April, prevails for about 6 months of the year. Average high temperatures, during summer months, range from 27^o C to 32^o C (80^o F to 90^o F). A typical day is mostly sunny, with scattered white clouds. Thundershowers frequently lower local temperatures and an ocean breeze usually appears in the afternoon. Occasional cool days occur in November, but winter weather starts in January and extends through February and March.

The dominant weather pattern during the wet season (May to October) is characterized by southeast winds, which travel clockwise around the Bermuda High. The southeast wind brings moisture and warm air, which help produce almost daily thundershowers. Approximately 70 percent of the average annual rainfall occurs during this period. Weather patterns in the dry season (November to April) are influenced by cold continental air masses. Rains occur when these masses move over the Florida peninsula and meet warmer air. In contrast to localized heavy thundershowers during the wet season, rains are light and tend to be uniform in distribution during the dry season (NASA 1979).

Rainfall amounts are gathered from several collecting stations that provide both long-term records (Merritt Island and Titusville) and site-specific data of special interest to KSC. Mean annual rainfall for Merritt Island and Titusville are 131.1 cm (51.6 in) and 136.6 cm (53.8 in), respectively. Annual rainfall varies widely. Rainfall for Merritt Island ranges from 77.5 cm (30.5 in) to 217.7 cm (85.7 in), and rainfall Titusville from 84.8 cm (33.4 in) to 207.5 cm (81.7 in) (NASA 1997a).

3.2.2 Air Quality

Ambient air quality at the proposed site is influenced by KSC operations, land management practices, vehicle traffic, and emission sources outside of KSC. Daily air quality conditions are influenced primarily by vehicle traffic, fuel combustion at high temperature hot water plants, standard refurbishment and maintenance operations, wildfires, and controlled burning operations. Air quality at KSC is also influenced by emissions from two regional power plants, which are located within a 16.1 km (10 mi) radius of KSC. Space launches and controlled burns (to reduce vegetative fuel loads) influence air quality as episodic events. Automobile emissions are one of the most influential factors contributing to air quality fluctuations routinely occurring on KSC. Mobile sources and the control of their emissions are regulated under the CAA. A summary of air source emissions standards for KSC is provided in Table 3-1. The calculations are based on emission factors in EPA's AP-42 Manual (2000).

The ambient air quality at KSC is monitored at one Permanent Air Monitoring System (PAMS) station, PAMS A. PAMS A is located approximately 4.6 km (7.36 mi) northeast of Alternative 1 and approximately 6 km (9.6 mi) north of Alternative 2 (Figure 3-1).

PAMS A includes instruments for continuously monitoring sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), total inhalable (10-micron) particulates. PAMS A also includes a meteorological tower with instruments for measuring wind speed, wind direction, high and low temperature, and relative humidity (Hall et. al. 1986).

A summary of air quality parameters collected from the PAMS A facility from October 2001 through September 2002 is provided in Table 3-2. Primary or secondary air quality standards for O_3, CO, NO_2, or SO_2 were not exceeded for that period. The maximum hourly average value for O_3 was 75 parts per billion (ppb) in April 2002. The maximum eight hour average value for O_3 was 48.9 ppb in April 2002. The maximum 24-hour (hr) average value for SO_2 was 8.8 ppb, in October 2001. The maximum hourly average value for NO_2 was 29.1 ppb in October 2001. The maximum hourly average value for CO was 6.9 ppm in March 2002. Particulate Matter (PM)-10 and PM-2.5 were not monitored within the last year.

The maximum O_3 value occurs in April when the Bermuda High sets up a stagnant weather condition. The maximum CO level was probably the result of either the use of a portable generator, a vehicle motor running in the area, or Center-wide controlled burns. NO_2 and SO_2 emissions are related to fuel combustion by utilities and services and mobile sources. The strong correlation between elevated NO_2 and SO_2 levels and prevailing westerly winds suggest that power plants to the west of KSC could be the primary source of these emissions (Drese 1985).

Table 3-1. State and Federal Ambient Air Quality Standards

Pollutant	Average Time	State of Florida Standard	Federal Primary Standard	Federal Secondary Standard
Carbon Monoxide	8 hour*	9 ppm ($10\ mg/m^3$)	9 ppm ($10\ mg/m_3$)	
	1 hour*	35 ppm ($40\ mg/m_3$)	35 ppm ($40\ mg/m^3$)	
Lead	Quarterly Arithmetic Mean	$1.5\ \mu g/m^3$	$1.5\ \mu g/\ m^3$	(same as primary)
Nitrogen Dioxide	Annual Arithmetic Mean	0.05 ppm ($100\ \mu g/m^3$)	0.053 ppm ($100\ \mu g/m^3$)	(same as primary)
Ozone	1 hour+	0.12 ppm ($235\ \mu g/m^3$)	0.12 ppm ($235\ \mu g/m^3$)	(same as primary)
	8 hour^	0.08 ppm ($157\ \mu g/m^3$)	0.08 ppm ($157\ \mu g/m^3$)**	(same as primary)
Sulfur Dioxide	Annual Arithmetic Mean	0.02 ppm ($60\ \mu g/m^3$)	0.03 ppm ($80\ \mu g/m^3$)	
	24 hour*	0.1 ppm ($260\ \mu g/m^3$)	0.14 ppm ($365\ \mu g/m^3$)	
	3 hour*	$1300\ \mu g/m^3$ (0.5 ppm)		$1300\ \mu g/m^3$ (0.50 ppm)
Inhalable Particulates (PM-10)	Annual Arithmetic Mean	$50\ \mu g/m^3$	$50\ \mu g/m^3$	(same as primary)
	24 hour*	$150\ \mu g/m^3$	$150\ \mu g/m^3$	(same as primary)
Particulates (PM-2.5)	Annual Arithmetic Mean		$15\ \mu g/m^3$ **	(same as primary)
	24 hour		$65\ \mu g/m^3$ **	(same as primary)

*Not to be exceeded more than once per year. (Parenthetical value is an approximately equivalent concentration.)

+Not to be exceeded an average of more than one day per year.

^Maximum 8 hour average concentration. Twenty-one days (70%) are required to yield a valid month. (%) – Percent of valid data for month.

** The ozone 8 hour standard and the PM-2.5 standards are included for information only. A 1999 Federal court ruling blocked implementation of these standards, which EPA proposed in 1997. EPA has asked the U.S. Supreme Court to reconsider that decision.

Source: Florida Department of Environmental Regulation (FDER) 1982.

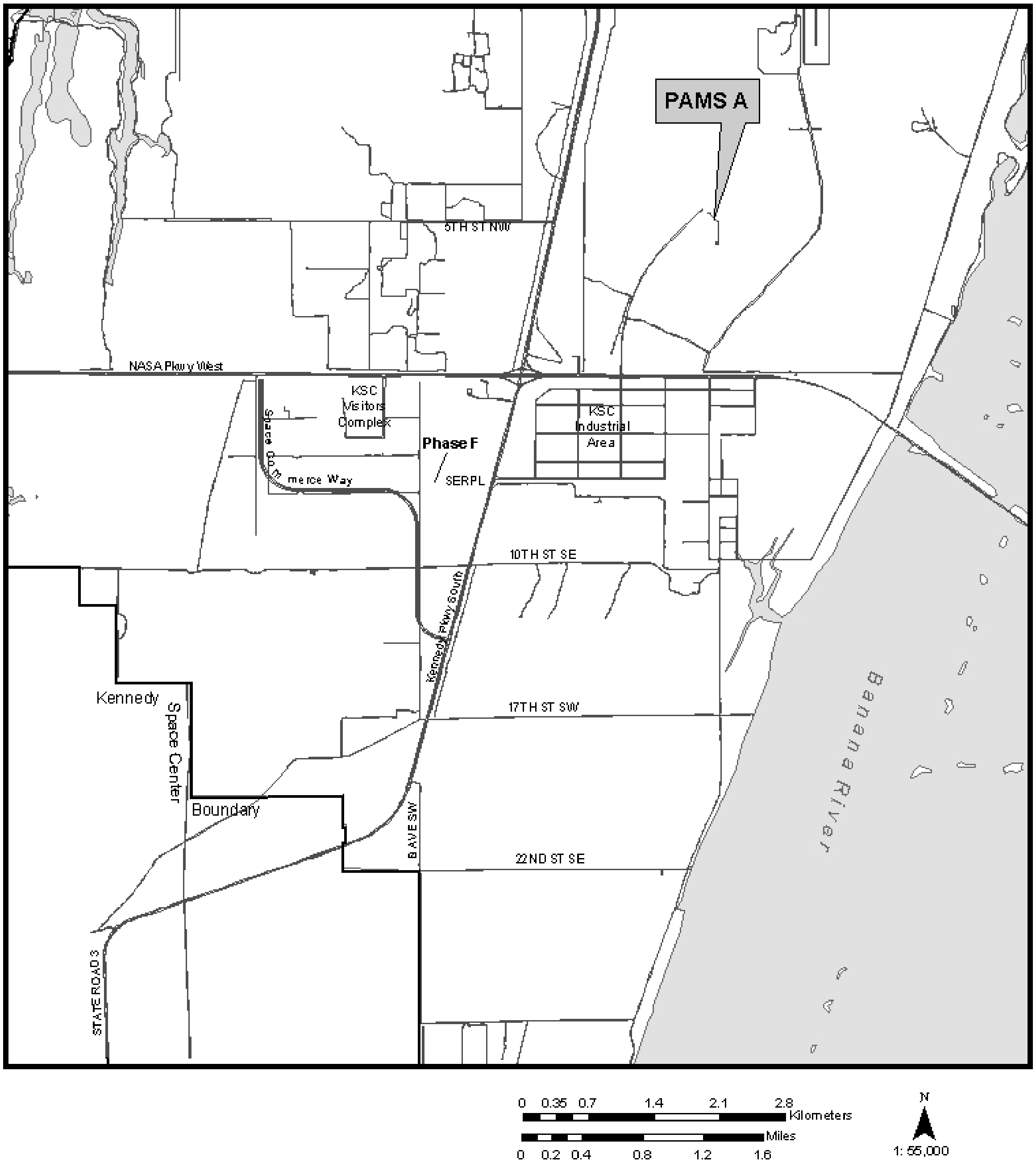

Figure 3-1. Permanent Air Monitoring Station (PAMS) on John F. Kennedy Space Center, Florida.

Table 3-2. KSC Air Quality Data Summary PAMS A, 2002

Parameter	Federal (4) and State Standard	Jan	Feb	Mar	Apr	May	June
Ozone (ppb)	Primary 80 (8 hr) (1)** Secondary 120 (1hr-AVG)	 31.4 40 (83.2%)	 40.8 45 (98.1%)	 44.4 47 (99.9%)	 48.7 75.3 (97.5%)	 46.0 54.9 (90.5%)	 42.1 54.5 (78.9%)
Sulfur Dioxide (ppb)	Primary 140 (24 hr) (2,4) Secondary 500 (3 hr) (3)	3.6 5.1 (86.8%)	3.5 3.4 (99.4%)	3.9 3.8 (99.5%)	2.7 3.1 (97.5%)	2.7 2.8 (89.4%)	2.9 3.3 (99.0%)
Nitrogen Dioxide (ppb)	(1 hr-AVG) 50 (ANNUAL-AVG) (3)	24.1 2.5 (76.1%)	14.5 2.8 (83.8%)	13.3 3.0 (99.7%)	19.8 3.3 (96.3%)	4.8 3.3 (51.1%)	9.0 3.3 (87.9%)
Carbon Monoxide (ppm)	35 (hr-AVG) (1) 9 (8 hr) (2)	1.0 0.6 (86.8%)	0.3 0.3 (99.3%)	6.9 1.3 (99.7%)	0.7 0.4 (97.5%)	0.7 0.3 (90.5%)	0.7 0.45 (99.0%)
Parameter	**Federal (4) and State Standard**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Ozone (ppb)	Primary 80 (8 hr) (1)** Secondary 120 (hr-AVG) (1)	41.5 52.5 (84.8%)	27.0 35.7 63.4%	24.7 40.1 (72.5%)	37.3 39.8 (98.5%)	48.9 55.3 (99.9%)	32.4 42 (99.6%)
Sulfur Dioxide (ppb)	Primary 140 (24 hr) (2, 4) Secondary 500 (3 hr) (3)	2.7 2.9 (99.2%)	3.2 3.6 (80.2%)	4.2 4.0 (72.8%)	8.8 9.1 (96.9%)	3.0 3.4 (99.0%)	2.9 3.4 (98.8%)
Nitrogen Dioxide (ppb)	(1 hr-AVG) 50 (ANNUAL-AVG) (3)	17.2 3.3 (98.4%)	13.5 3.2 (80.4%)	11.7 3.2 (79.3%)	29.1 0.2 (77.8%)	9.3 0.2 (93.9%)	18.7 1.5 (94.5%)
Carbon Monoxide	35 (hr-AVG) (1) 9 (8 hr) (2)	0.6 0.4 (99.5%)	9.3 1.5 (80.1%)	0.6 0.4 (79.3%)	0.7 0.9 (98.5%)	0.9 0.3 (99.7%)	0.6 0.4 (99.7%)

(1) Maximum hourly average concentration (not to be exceeded more than once per year).
(2) Maximum time-period average concentration (not to be exceeded more than once per year).
(3) Annual arithmetic mean.
(4) Federal and State standards are identical except for SO_2; State Primary (24 hour) is 100 ppb.
** The ozone 8 hour standard and the PM-2.5 standards are included for information only. A 1999 Federal court ruling blocked implementation of these standards, which EPA proposed in 1997. EPA has asked the U.S. Supreme Court to reconsider that decision.
Hr = hourly; AVG = average.
Twenty-one days are required to yield a valid month.
(%) = Percentage of validation the month.
Sources: NASA 2002.

3.2.2.1 Ozone (O_3)

Ozone is the most consistently elevated criteria pollutant at KSC (Hall *et al*. 1986). Ozone is formed in a series of chemical reactions between oxidant precursors such as volatile organic carbons (VOC) and NO_2 in the presence of sunlight (FDER 1982). Local sources, as well as distant metropolitan areas, can contribute to elevated ozone levels. Ozone precursors generated over land are directed offshore by prevailing evening winds. Morning sunlight catalyzes the conversion to ozone and onshore breezes can return ozone to the land mass during the day. KSC records indicate that Federal primary or secondary ambient air quality standards for O_3 have been exceeded six times since 1988. However, the average levels have been below these standards for the last 10 years.

Figure 3-2 displays the maximum monthly 8 hr and 1 hr O_3 values from October 2001 to September 2002 and the 10-year means for comparison. The 1 hr data were below the associated 10-year mean for most of the year except November 2001 and April 2002. These data are consistent with the typical bi-annual peaks found with ozone. The 75 ppb (0.075 ppm) in April 2002 was 62.5 percent of the 1 hr State and Federal standard of 120 ppb (0.120 ppm). The 8 hr monthly values were below the 10-year mean except in November 2001. The 8 hr monthly value of 48.9 ppb (0.0489 ppm) was 65.2 percent of the proposed 8hr State and Federal standard of 75 ppb (0.075 ppm).

3.2.2.2 Sulfur Dioxide (SO_2)

Figure 3-3 shows the maximum monthly 24 hr and 3 hr mean values from October 2001 to September 2002 and the running 10-year means for comparison. The 24 hr SO_2 data fluctuated around the 10-year mean for 6 months between October 2001 and September 2002. The 10-year mean was exceeded during the following months; October 2001, January, February, March, August, and September 2002. The highest 24 hr average was 8.8 ppb in October 2001, which was only 6.3 percent of the primary Federal standard of 140 ppb. The 3 hr values were above the 10-year mean in two months: October 2001 and January 2002. The highest 3 hr average was 9.1 ppb in October 2001, which was only 1.8 percent of the Federal primary standard of 500 ppb.

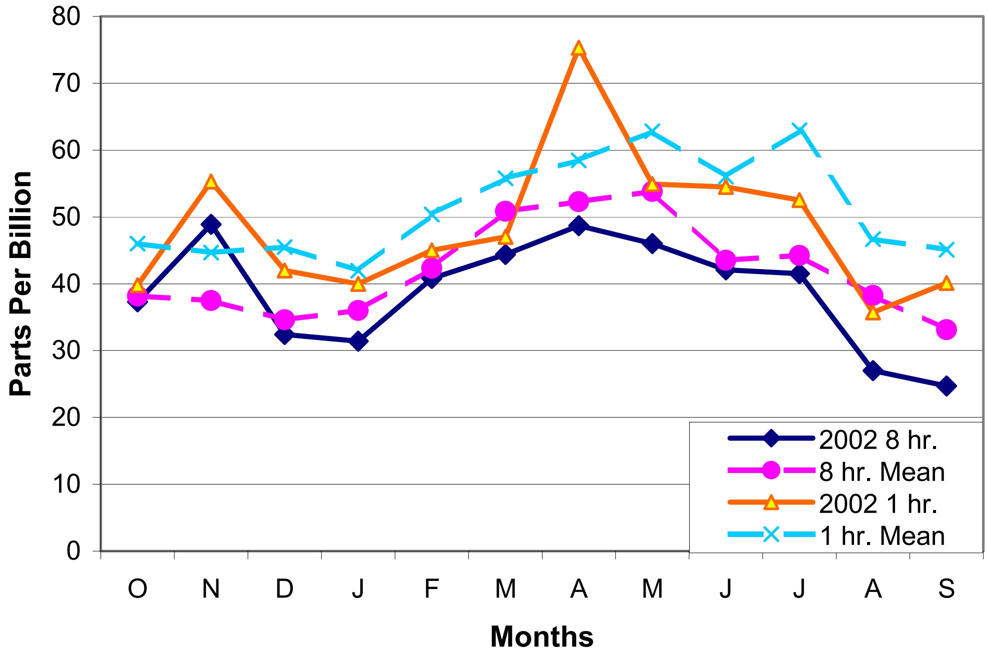

Figure 3-2. Maximum Monthly Values for 1 hour and 8 hour O_3 from Oct. 2001 to Sept. 2002 and the 10-Year Mean.

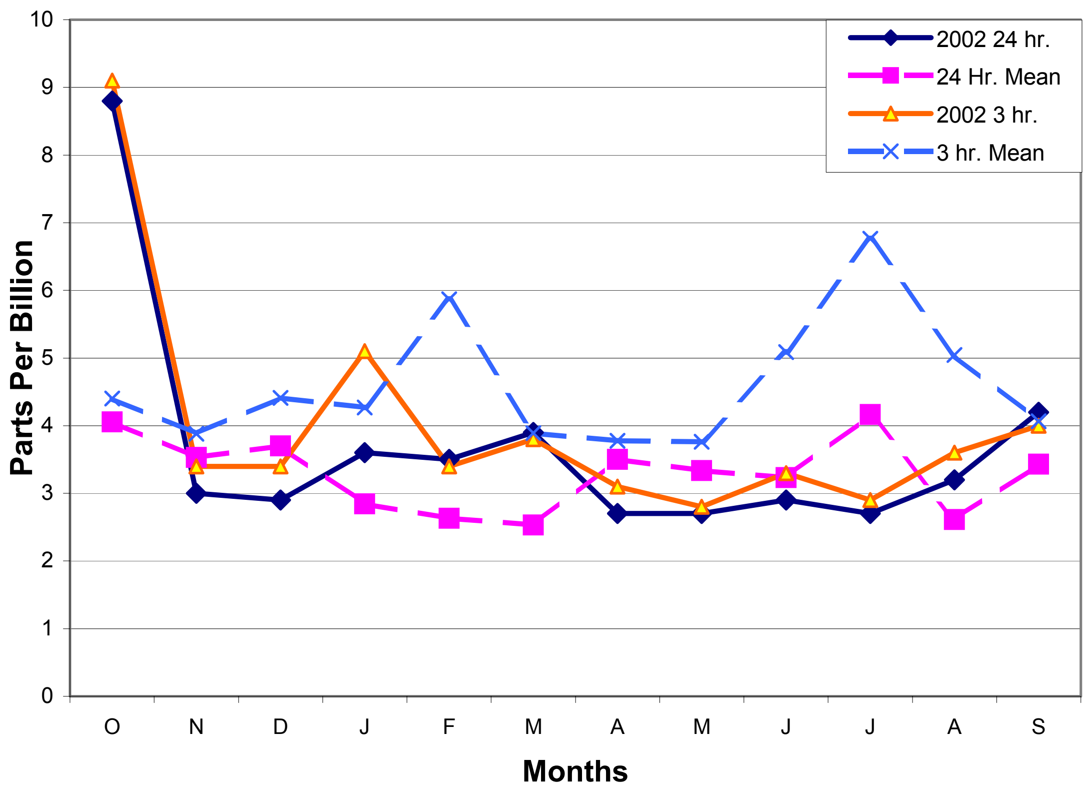

Figure 3-3. Maximum Monthly Values for 3 hour and 24 hour SO_2 from Oct. 2001 to Sept. 2002 and the 10-Year Mean.

3.2.2.3 Nitrogen Dioxide (NO_2)

Figure 3-4 displays the maximum monthly annual average and the 1 hr NO_2 values from October 2001 to September 2002, and the 10-year means for comparison. The annual average NO_2 values were above the 10-year mean from December 2001 through September 2002. The highest annual average value was 3.3 ppb for April, May, June, and July 2002, while the standard is 50 ppb (100 ug/m^3). The 1 hr data were at or above the associated 10-year mean for most of the year with the exception of May and June 2002. The highest 1 hr NO_2 value was 29.1 ppb in October 2001.

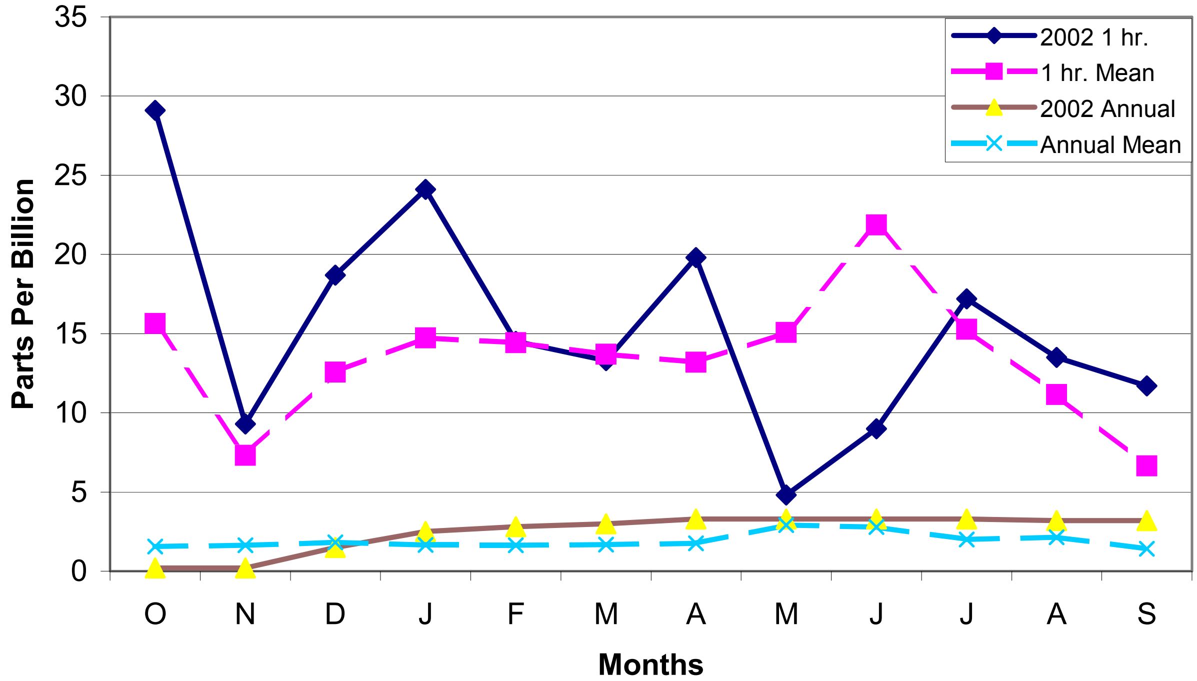

Figure 3-4. Maximum Monthly Values for 8 hour and 3 hour for NO_2 from Oct. 2001 to Sept. 2002 and the 10-Year Mean.

3.2.2.4 Carbon Monoxide (CO)

Figure 3-5 displays the maximum monthly 1 hr and 8 hr CO values from October 2001 to September 2002 and the 10-year means for comparison. The maximum monthly CO values for 1 hr data were below the associated 10-year means from October 2001 to September 2002 except in March. The highest 1 hr average of 6.9 ppm in March 2002 was 19.7 percent of the primary 1 hr standard of 35 ppm. The 8 hr monthly values were below the 10-year mean except in October 2001 and March 2002. The highest 8 hr value of 1.3 ppm, occurred in March 2002 and was 14.4 percent of the proposed 8 hr Federal and State standard of 9.0 ppm.

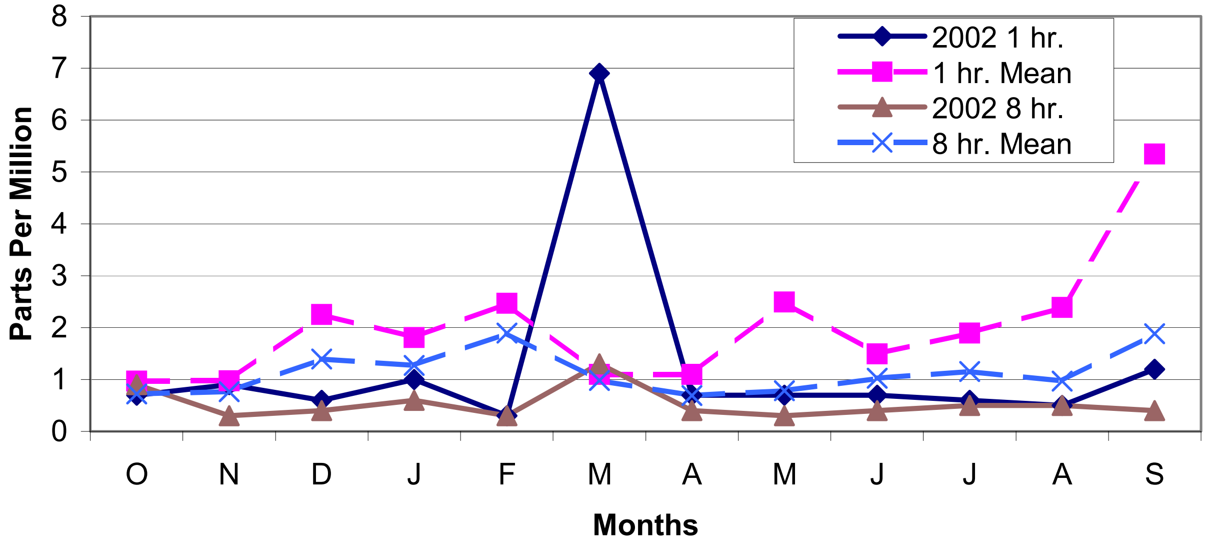

Figure 3-5. The Maximum Monthly Values for 1 hour and 8 hour CO from Oct. 2001 to Sept. 2002 and the 10-Year Mean.

Under the CAA, compliance with the National Ambient Air Quality Standards (NAAQS) for an area is the primary objective of the regulations. KSC is located within an area, classified as "in attainment" for all the pollutants listed in Table 3-1. This classification means that pollutant concentrations within the KSC boundaries are below the NAAQS established by EPA. Additionally, this classification triggers the requirements of the Prevention of Significant Deterioration (PSD) program, but not the more stringent requirements of the New Source Review (NSR) program.

The CAA requires each state to develop and submit a State Implementation Plan (SIP) to EPA for approval. The purpose of the SIP is to provide a framework by which each state will ensure compliance with the NAAQS within a reasonable time. The majority of the regulations adopted by FDEP are incorporated in Florida's SIP. Consequently EPA can enforce Florida regulations, including the Florida requirements for construction and operating permits, should FDEP fail to do so.

Ambient air quality standards and area designations are contained in Chapters 62-272 and 62-275, FAC and incorporate the NAAQS and the more stringent Florida Ambient Air Quality Standards (FAAQS). The FAAQS are listed along with the NAAQS in Table 3-1.

3.3 AMBIENT NOISE

Noise is an undesirable sound that interferes with hearing, speech, and communication. Some noise is intense enough to damage hearing or physical structures. Given certain intensities, frequencies, amplitudes, and durations, noise can change the behavior of humans and other animals. Noise is typically derived from human activities although some natural sounds that are very loud may be considered noise. The frequency sensitivity of the human ear is used to describe sound measures and is measured in decibels (dB) or decibels measured on an A scale (dBA).

Noise generated at KSC by day-to-day operations, space vehicle launches, and Shuttle landings can be attributed to six general sources: 1) Shuttle reentry sonic booms, 2) launches, 3) aircraft movements, 4) industrial operations, 5) construction, and 6) traffic noise. The proposed development of the ISRP on KSC may increase ambient noise sources within three of the six categories of noise; industrial operations, construction, and traffic. Development and construction of the ISRP will involve the use of routine commercial construction techniques common to similarly scaled projects on KSC. Construction noise has been measured from a peak of 110 dBA at the source to 55 dBA at a distance of approximately 122 m (400 ft) (NASA 2002). The current ambient noise levels at the alternative sites are similar to those measured within the KSC Industrial Area with light traffic (45-55 dBA) (NASA 1978).

3.4 GEOLOGY AND SOILS

3.4.1 Geology

The geologic history of Florida is complex with repeated periods of deposition, when the Florida Plateau was submerged, and erosion, when the seas recessed (Randazzo 1997, Scott 1997). The oldest formations known to occur beneath Brevard County and KSC were deposited in the early Eocene in an open ocean (Cooke 1945). This was followed by a withdrawal of the sea and a period of erosion. In the late Eocene, the seas advanced and limestones of the Ocala group were deposited (Cooke 1945). Following another period of recession of the sea and erosion of the land surface, the Hawthorn formation of calcareous clay, phosphatic limestone, phosphorite, and radiolarian clay were deposited in the late Miocene (Cooke 1945, Brown *et al.* 1962). Overlying the Hawthorne formation are unconsolidated beds of fine sand, shells, clay, and calcareous clay of late Miocene or Pliocene age (Brown *et al.* 1962). Surface strata in Brevard County are primarily unconsolidated white to brown quartz sand containing beds of sandy coquina of Pleistocene and Holocene age (Brown *et al.* 1962).

Repeated glaciation of the northern hemisphere during the Pleistocene (ca. 1.6 million years before present (yr B.P.) to 13,000 yr B.P.), produced fluctuations in sea level (Field and Duane 1974, Bowen 1978, Delcourt and Delcourt 1981). The change in sea levels between the Pleistocene and Holocene (since ca. 13,000 yr B.P.) shaped the surface of Brevard County. The outer barrier island and Cape Canaveral formed after sea levels rose when the Wisconsinan glaciers retreated (Brooks 1972, Davis 1997). Cape Canaveral is part of a prograding barrier island complex, the result of southward growth of an original cape at the site of the present False Cape (White 1958, 1970). Merritt Island formed as a prograding barrier island complex but is older than Cape Canaveral; the eastern edge of Merritt Island at its contact with the Mosquito Lagoon and the Banana River forms a relict cape aligned with False Cape (White 1958, 1970). Multiple dune ridges apparently represent successive stages of growth. The western portion of Merritt Island is substantially older than the east (Brooks 1972, Clapp 1987). Erosion has reduced the western side to a nearly level plain (Brown *et al.* 1962).

Lithology, stratigraphy, and geologic structure are important controls of: 1) quality of groundwater, 2) distribution of aquifers and confining beds, and 3) the availability of groundwater. Four distinct geologic units are characteristic of the coastal area of east-central Florida and lie beneath KSC (Table 3-3). In descending order, these units are: Pleistocene and Recent age sands with interbedded shell layers, Upper Miocene and Pliocene silty or clayey sands, Central and Lower Miocene compacted silts and clays, and Eocene limestones (Edward E. Clark 1987). North-south and east-west geological cross sections (Figures 3-3, 3-4, 3-5) were developed by Edward E. Clark Engineers-Scientists, Inc. (Edward E. Clark 1987) based on data collected during the construction phase of facilities for the Manned Lunar Landing Program at Merritt Island and Cape Canaveral, Florida.

Table 3-3. Generalized Stratigraphy at Kennedy Space Center[1]

Geologic Age	Formation Name	Aquifer	Physical and Water Bearing Characteristics
Holocene			Highly variable and undifferentiated deposits.
Pleistocene	Anastasia Formation	Surficial Aquifer System	Sand, shell, clay, coquina, and mixtures. Yields moderate amounts of water, depending permeability of deposits.
Pliocene	Tamiami Formation		Interbedded limestone, coquina, sand and clay (eastern). Shell, sand, clay and cemented zones (western).
Miocene	Hawthorn Formation	Intermediate Confining Unit	Sand clay, green and brown clays, and some limestones. Generally impermeable; poor water yield except for some thin shell and limestone beds.
Oligocene	Suwannee Limestone	Floridan Aquifer System	Gray to cream colored, clayey, granular limestone. Poor water yields.
Eocene	Ocala Limestone		Gray to cream colored, porous massive limestone, generally yields good quantity of water.
	Avon Park Limestone		Cream colored to tan, porous, chalky, and hard crystalline limestone and dense dolomite.
	Lake City Limestone		Cream colored to tan, porous, chalky, and hard crystalline limestone and dense dolomite.
	Oldsmar Limestone		Not commonly tapped by wells.

[1]Toth (1987)

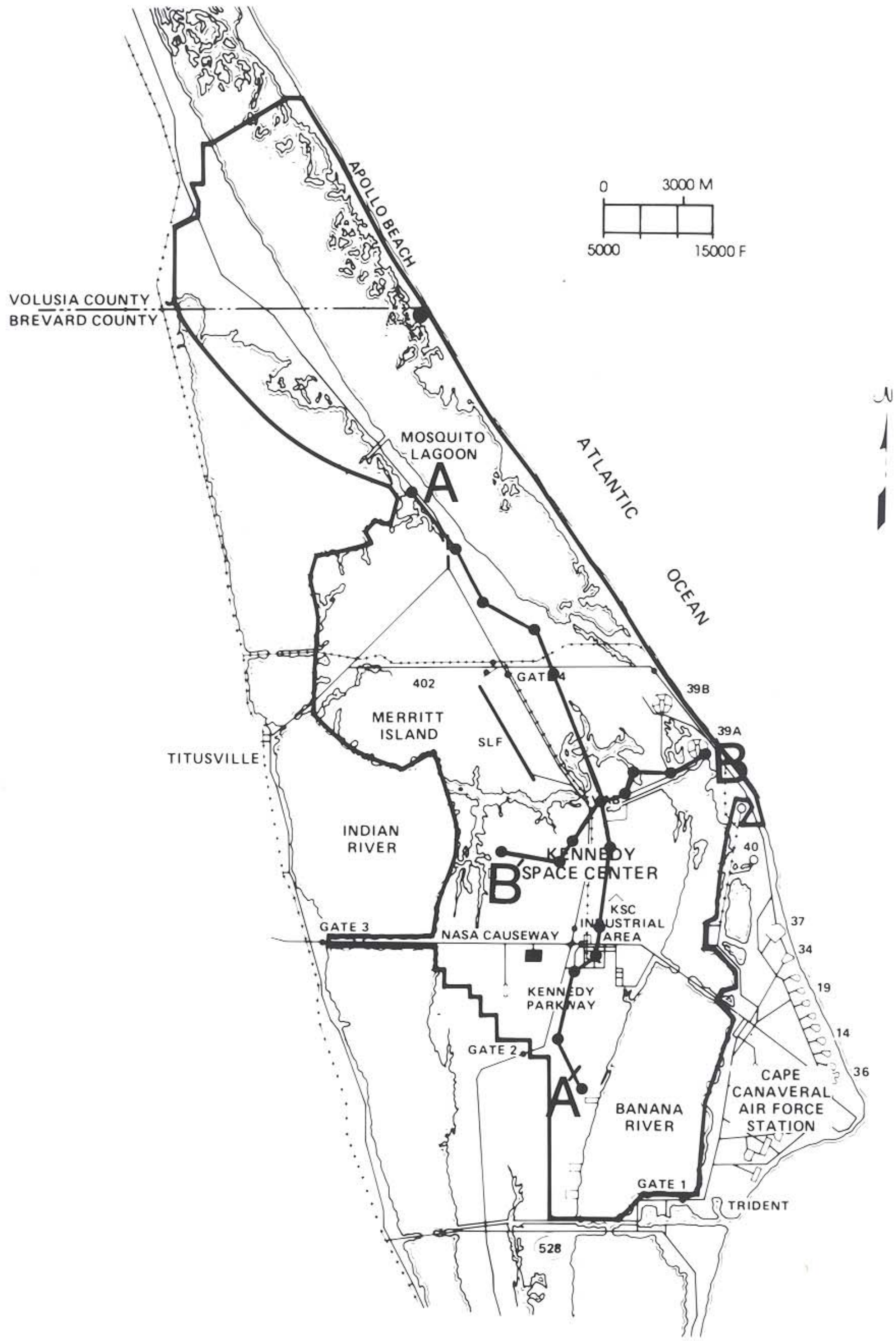

Figure 3-6. Location of North to South and East to West Geologic Cross-sections on Kennedy Space Center (redrafted from Edward E. Clark 1987).

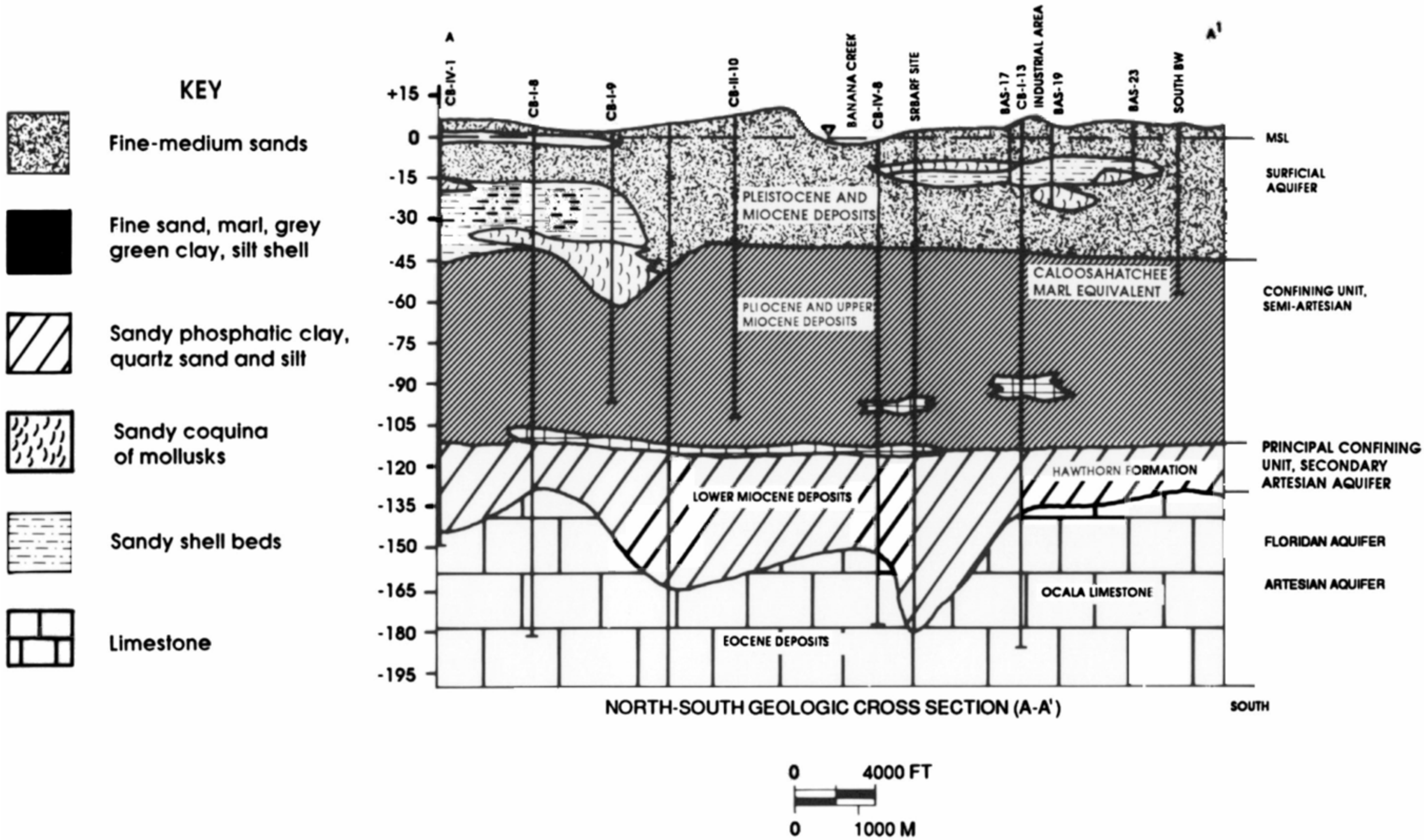

Figure 3-7. North to South Geologic Cross-section for Kennedy Space Center (redrafted from Edward E. Clark 1987). Vertical scale is elevation in feet relative to mean sea level.

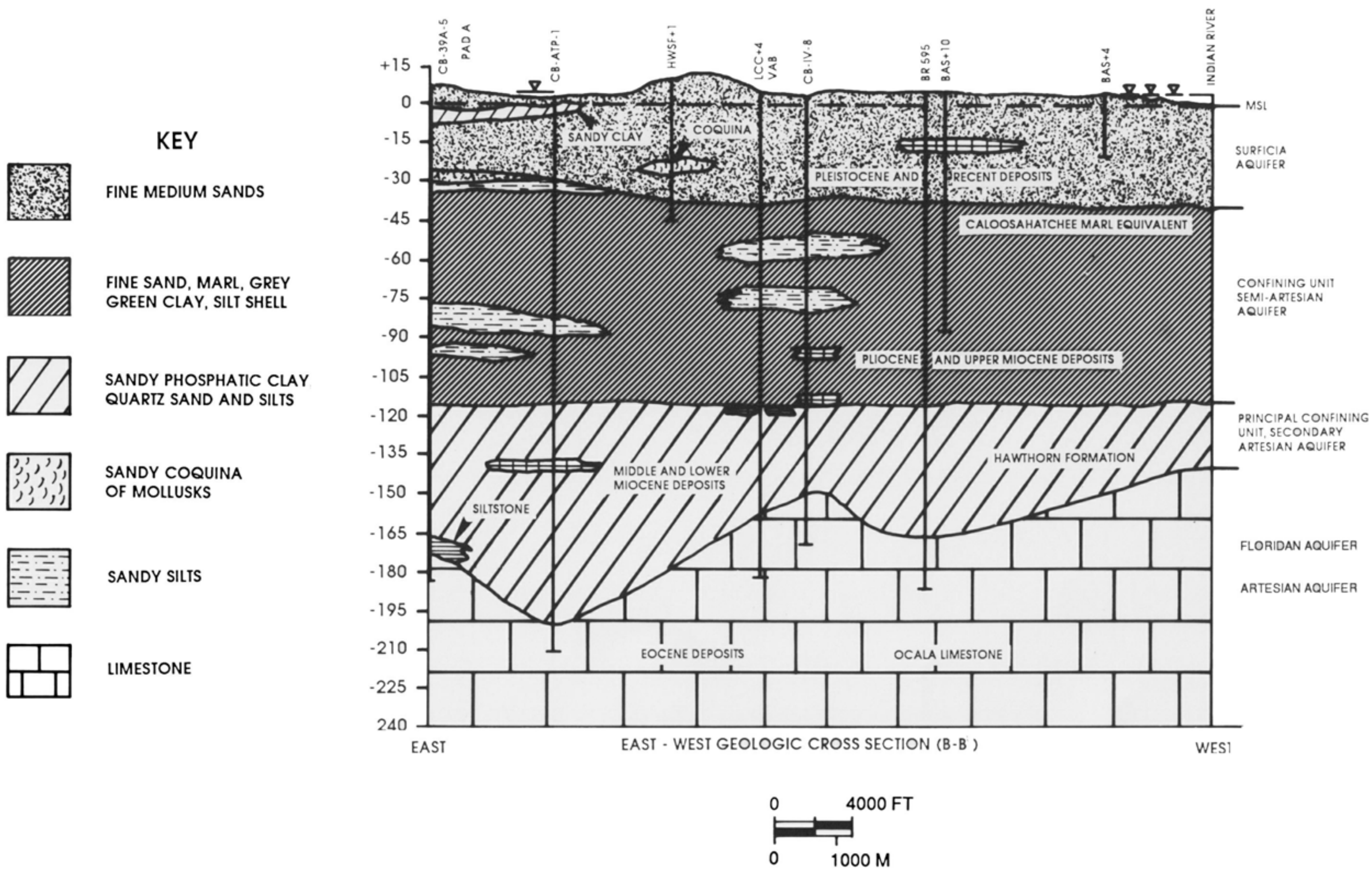

Figure 3-8. East to West Geologic Cross-section for Kennedy Space Center (redrafted from Edward E. Clark 1987). Vertical scale is elevation in feet relative to mean sea level.

Pleistocene and Recent deposits are characterized by 10.7-13.7 m (35 to 45 stratigraphic ft) of fine to medium sands with varying amounts of shell and interbedded layers of shell deposited by long shore currents and wave action (high energy environments) and subjected to varying degrees of oxidation. The upper limits of Pleistocene deposits range from 1.5-2.4 m (5 to 8 ft) above mean sea level (MSL) or the elevation of the Silver Bluff terrace, the youngest terrace formed as the result of the Pleistocene age sea level fluctuation (Brown *et al*. 1962). The characteristics of these Pleistocene deposits have been altered by cementation and compaction; in the upper horizons discontinuous layers of limerock hardpan, dark brown humic sandstone hardpan, silt, and clay can be found (Edward E. Clark 1987).

Visually, little difference exists between the upper Hawthorn and Upper Miocene deposits. These deposits, generally occurring between a top elevation of -9.1 m (-30 ft) MSL and a base elevation of -35.0 m (-115 ft) MSL, consist primarily of sands, silts, and clays with minor occurrences of limestone and shelly sands. They were deposited in shallow marine and lagoonal environments subjected to numerous sea level fluctuations resulting in many localized interbedded, discontinuous strata. The upper limits of these undifferentiated deposits are equivalent to the Caloosahatchee Marl formation and, in the northern end of Merritt Island; the top of the Pliocene Tamiami formation occurs at approximately -87 ft (26.5 m) MSL. Within the Tamiami formation lays a narrow band of shelly conglomerate or medium hard limestone. The contact between the undifferentiated sediments and the overlying surficial sands is conformable and gradational over approximately 0.9 m (3 stratigraphic ft), but is nonetheless distinct (Edward E. Clark 1987).

The Hawthorn formation was uniformly deposited on the karst Ocala limestone surface while the Ocala limestone was submerged during the Miocene Epoch. The top of the Hawthorn formation occurs approximately -35.0 m (-115 ft) MSL and extends down to the Ocala limestone. The Hawthorne formation consists of massive beds of calcareous clays and silts, sandy phosphatic limestone, and phosphatic clays. The beds are identified by varying amounts of phosphatic material (formed from residue of shallow marine life) and a dramatically high natural gamma ray signature on geophysical well logs. Associated with this formation are at least two thin (approximately 0.6 to 0.9 m (2-3 ft)), discontinuous conglomerate limestone/sandstone beds. The upper bed, although not always present, is located near the -36.6 m (-120 ft) MSL mark and the location of the lower bed ranges between approximately -39.6 m (-130 ft) MSL and -42.7 m (-140 ft) MSL depending on the presence or absence of faulting. Its thickness depends on the extent to which the Ocala limestone surface has been eroded. The top of the Hawthorn formation gradually changes to Upper Miocene silts and clays. Numerous geophysical logs (natural gamma) indicate the diagnostic signatures of the Hawthorn formation beginning approximately -33.5 m (-110 ft) MSL to -36.6 m (-120 ft) MSL (Edward E. Clark 1987).

At least four limestone formations from the Eocene Epoch make up the Floridan aquifer system in the KSC area (Table 3-3). The upper limestones, the Ocala group, are the best defined as they have been drilled numerous times for testing prior to the design of facilities for the Manned Lunar Landing Program and have been used as an artesian water source. The Ocala limestone is of late Eocene age and was formed in a shallow sea environment. This limestone was later exposed to subaerial processes above sea level where it developed karst topography with sinks, cavities, and solution channels (Edward E. Clark 1987).

The Florida Platform exhibits high seismologic stability with very few confirmed earthquakes (Smith and Lord 1997).

3.4.2 Soils

The soils of the proposed ISRP development sites are mapped in the soil surveys for Brevard County (Huckle *et al.* 1974). Soils of Alternative 1 (Phases A-E) are primarily Copeland complex (Figure 3-9, Table 3-4) with significant areas of Wabasso sand, Bradenton fine sand-shallow variant, Anclote sand, and Swamp soils. Phase F (Figure 3-9, Table 3-5) is primarily Copeland complex soils with a minor amount of Chobee sandy loam. Alternative 2 (Phases A-E) (Figure 3-10, Table 3-6) is primarily Immokalee sand with significant areas of Anclote sand and Pomello sand. See Appendix F for a description of these soils.

Although these sites are in close proximity, the soil patterns are quite different. Soils differ through the interaction of several factors: climate, parent material, topography, organisms, and time (Jenny 1941, 1980). The primary source of parent material for KSC soils is sands of mixed terrestrial and biogenic origin. The terrestrial sediments are quartzose with low feldspar content (Milliman 1972). The biogenic carbonate fraction of the sand is primarily of mollusk or barnacle origin (Milliman 1972). The Cape Canaveral-Merritt Island complex is not all of the same age. Soils on Cape Canaveral, False Cape, and the barrier island section on the east side of Mosquito Lagoon are younger than those of Merritt Island and therefore have had less time to weather. The eastern and western sections of Merritt Island differ in age. The eastern section of Merritt Island inland to about Kennedy Parkway has a marked ridge-swale topography presumably retained from its formation as a barrier island; west of Kennedy Parkway, the island is flatter, without obvious ridges and swales probably due to the greater age of this topography. Topography has a dramatic effect on soil formation within landscapes of similar age on Merritt Island. Relatively small elevation changes cause dramatic differences in the position of the water table that, in turn, affect leaching, accumulation of organic matter, and formation of soil horizons.

The soils of Alternative 1 (Phases A-E) reflect the differing topography west of Kennedy Parkway South. The vegetation of Copeland and Bradenton soils was originally hammock (now converted to citrus). Wabasso soils supported flatwoods vegetation, while wetlands occurred on Anclote, Chobee, Felda, and Swamp soils, most of which have been converted to citrus agriculture on Alternative 1 and Phase F. The soils of Alternative 2 (Phases A-E; east of Kennedy Parkway South) reflect the ridge-swale topography of eastern Merritt Island. Pomello sand is the soil of the higher scrub ridges, Immokalee sand and Myakka sand support flatwoods vegetation, and Anclote sand supports wetlands primarily marshes.

Schmalzer *et al.* (2000, 2001) used 10 soil classes to characterize baseline chemical and physical properties of KSC soils and found significant differences for many parameters among these classes. Soils series of Alternative 1 (Phases A-E), Phase F, and Alternative 2 (Phases A-E) include four of these classes (Table 3-7). Since most of Alternative 1 has been in citrus agriculture, some properties of those soils should reflect past agriculture.

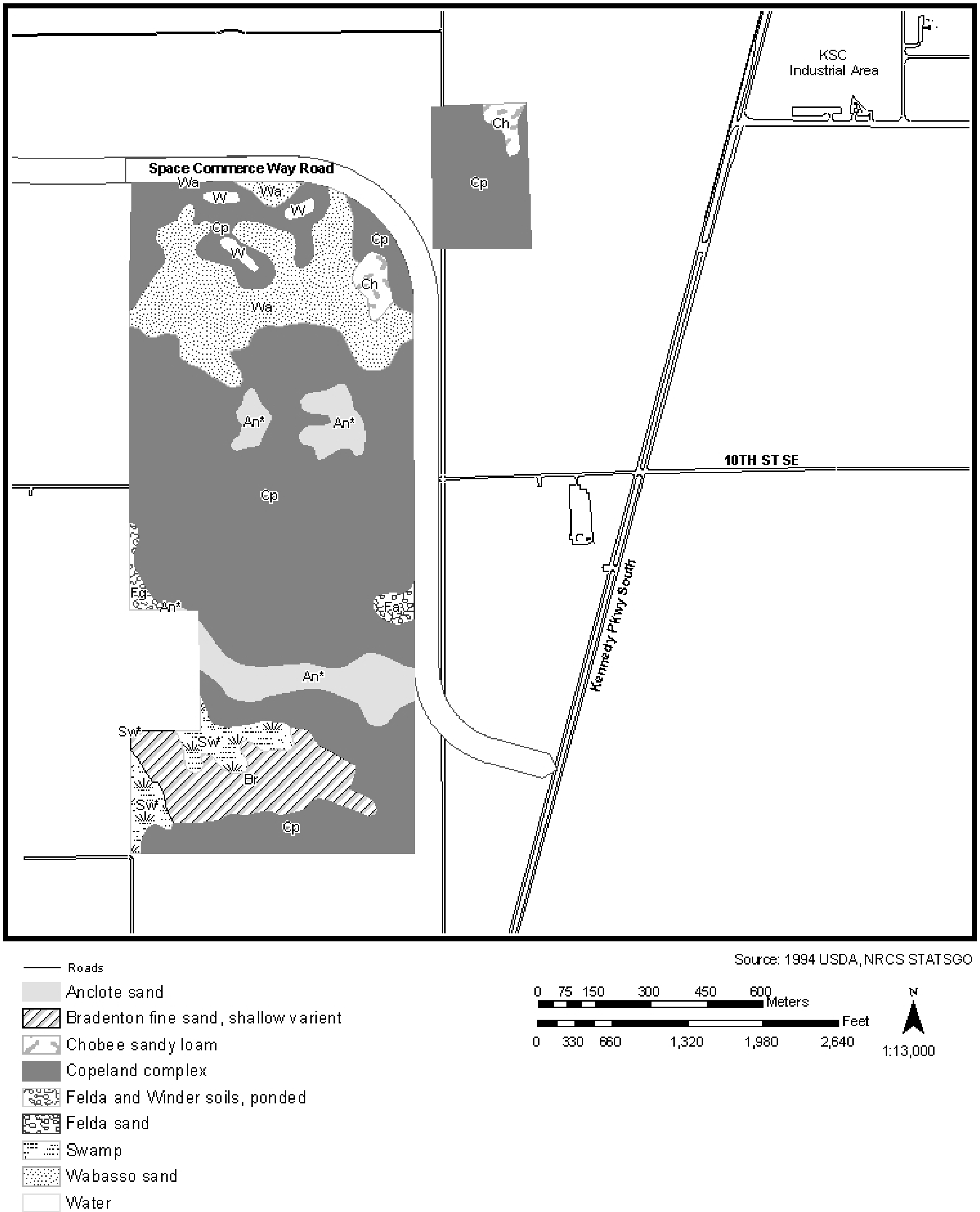

Figure 3-9. Soils of Preferred Alternative 1 and Phase F.

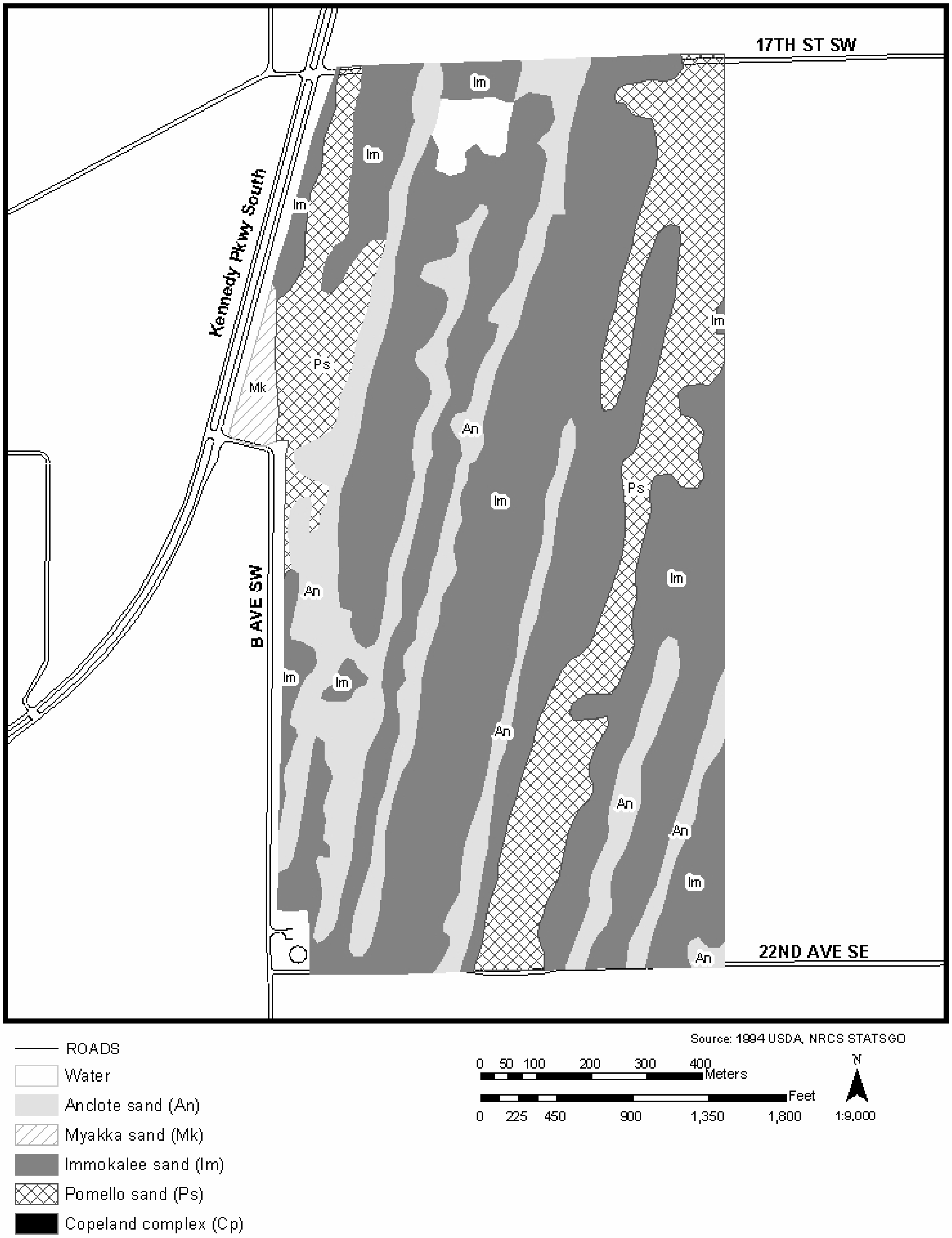

Figure 3-10. Soils of Alternative 2 Not Showing Phase F.

Table 3-4. Soils of Alternative 1 (Phases A-E)

Soil Series	Area (ac)	Area (ha)
Anclote sand	23.7	9.6
Bradenton fine sand- shallow variant	23.9	9.7
Chobee sandy loam	3.1	1.3
Copeland complex	201.0	81.3
Felda and Winder soils- ponded	2.0	0.8
Felda sand	2.1	0.8
Swamp	11.1	4.5
Wabasso sand	46.7	18.9
Water	2.4	1.0
Total	316.0	127.9

Table 3-5. Soils of Phase F

Soil Series	Area (ac)	Area (ha)
Chobee sandy loam	2.3	0.9
Copeland complex	22.0	8.9
Total	24.3	9.8

Table 3-6. Soils of Alternative 2 (Phases A-E)

Soil Series	Area (ac)	Area (ha)
Anclote sand	68.1	27.5
Immokalee sand	185.4	75.0
Myakka sand	3.5	1.4
Pomello sand	61.0	24.7
Water	3.7	1.5
Total	321.5	130.1

Table 3-7. Soil Classes with the Series and Land Cover Types in Each[1]

Soil Class and Series
Acid Scrub
Pomello
Flatwoods
Immokalee
Myakka
Wabasso
Hammocks
Bradenton, shallow variant
Copeland
Citrus Hammock
Hammock Types
Freshwater Wetlands
Anclote
Chobee
Felda
Felda & Winder, ponded
Swamp

[1] Schmalzer *et al.* (2001)

A baseline study was conducted to document the background chemical composition of the soils, groundwater, surface water and sediments on KSC (Schmalzer *et al.* 2000). Soil samples from 200 soil sampling locations, within 10 soil classifications through out KSC, were analyzed for organochlorine pesticides, aroclors, chlorinated herbicides, polycyclic hydrocarbons (PAH), total metals, pH, cat ion exchange capacity (CEC), bulk density, resistivity, and soil texture.

The Citrus Hammock soil class (Table 3-7) dominates the Alternative 1 (Phases A-F) site. Frequencies of organochlorine pesticides, chlorinated herbicides and PAH above the detection limits were slightly higher in the agricultural soil classes (e.g., Citrus Hammock) (Appendix A in Schmalzer *et al*. 2000). Metals, such as chromium, copper, manganese, and zinc, were above detection limits and appear to be higher than background levels (Appendix A in Schmalzer *et al*. 2000) in the Citrus Hammock soil classes. These metals are common in agricultural fertilizers and pesticides and were probably introduced periodically during the 100-year management of the area as citrus grove. Appendix G Table G-2 shows the results of the soil chemistry analysis for two soil sampling locations, SSC163, and SSC164, within or very near to Alternative 1 (Phases A-E). Sampling location SSC165 was located nearest to the Phase F parcel.

Acid Scrub and Flatwoods Soil Classes (Table 3-7) dominate the Alternative 2 (Phases A-E) site. The frequencies of organochlorine pesticides found above the detection limits in all soils were low. The Flatwoods soil class showed very low levels of the organochlorine pesticides, the source of which may be attributed to past agricultural practices within the area (Appendix G, Table G-2).

3.5 HYDROLOGY AND WATER QUALITY

3.5.1 Surface Water and Flood Plain

KSC is surrounded by the IRL system and the Atlantic Ocean. The IRL system has been designated an *Estuary of National Significance*, containing *Outstanding Florida Waters (OFW)* and an *Aquatic Preserve.* The IRL extends 250 km (155 mi) along the east coast of Florida from Ponce de Leon Inlet to St. Lucie Inlet near Stuart, Florida (Steward and Van Arman 1987). The IRL system consists of Mosquito Lagoon to the north, Banana River to the south, and Indian River to the west. Parts of all three lagoons are contained within the KSC boundaries. This aquatic resource contains one of the richest and most productive estuarine faunas in the continental US (Gilmore 1985). These basins are shallow, Aeolian lagoons with depths averaging 1.5 m (4.9 ft) and maximum depths of 9 m (29.5 ft) generally restricted to dredged basins and channels. Salinities vary from greater than 35 ppt to fresh water at drainage outfalls and some creeks. No fresh water creeks occur on KSC (Breininger *et al.* 1994).

Banana Creek drains numerous wetlands and impoundments within KSC adjacent to the Space Shuttle launch pads and Vehicle Assembly Building (VAB) via box culverts located northwest of the VAB to the Indian River. Salinity usually increases in a westward direction, but depending on wind direction, the IRL system can have a greater or lesser affect on the Banana Creek water quality. Other freshwater inputs to the estuarine system surrounding KSC include precipitation, stormwater runoff, discharges from impoundments, and groundwater seepage.

Surface waters at KSC include "Waters of the United States", "Navigable Waters" and "Waters of the State". Activities in these waters are subject to numerous Federal, State and regional regulations as discussed in Chapter 1. EPA regulates the discharge of pollutants into navigable waters of the U.S. under the Federal Clean Water Act of 1977 (CWA), as amended by the Water Quality Act of 1987. EPA has adopted numerous regulations to implement the CWA found in Title 40 CFR. The USACE administers dredge and fill activities in navigable waters through the authority of the Rivers and Harbors Act of 1899 (RHA), and in waters of the U.S. through Section 404 of the CWA.

State compliance with the CWA has been delegated to the FDEP. Today, Florida surface waters are designated according to five classifications based on their potential use and value (Table 3-8).

Table 3-8. Florida Surface Water Classifications

Class I	Potable Water Supplies
Class II	Shellfish Propagation and Harvesting
Class III	Recreation and Fish and Wildlife Propagation
Class IV	Agricultural Water Supplies
Class V	Navigation and Utility and Industrial Use

In compliance with 62-302.400 FAC, the State has classified all surface water surrounding KSC. All of the area of Mosquito Lagoon within KSC boundaries and the northern-most segment of the Indian River extending from the NASA Railway spur crossing, are designated as Class II - Shellfish Propagation or Harvesting. The remainder of surface waters surrounding KSC is designated as Class III – Recreation and Fish and Wildlife Propagation. Class III water standards are intended to maintain water quality suitable for body contact sports and recreation and the production of diverse fish and wildlife communities.

All surface waters within the MINWR have been designated as Outstanding Florida Waters (OFW) (62-302-700 FAC). The OFW designation supersedes other surface water classifications and water quality standards are based on ambient water quality below the existing levels; that is, these waters cannot be degraded below their ambient standards even if they are cleaner than the standards for that classification.

Fresh surface waters within KSC are primarily derived from the surficial groundwater, and shallow groundwater supports fresh water wetlands. Groundwater discharge to surrounding estuarine systems helps maintain lagoon salinity levels. Groundwater underflow is a major factor in establishing the equilibrium of the fresh-saltwater interface in the surficial aquifer system (Edward E. Clark 1987) prohibiting salt water from intruding into surface waters.

Several agencies including NASA, the USFWS, and Brevard County maintain water quality monitoring stations at surface water sites within and around KSC. The data collected are used for long-term trend analysis to support land use planning and resource management. Surface water quality at KSC is generally good, with the best areas of water quality being adjacent to undeveloped areas, such as Mosquito Lagoon, and the northern most portions of the Indian River and Banana River.

EO 11988 directs agencies to consider alternatives to avoid adverse effects and incompatible development in floodplains. The proposed ISRP alternatives are not located within the 100-year or the 500-year floodplain, and would not impact the nearby flood plain, so further consideration of floodplain management is not required.

3.5.1.1 Alternative 1

Surface waters on Alternative 1 (Phase A-E) include 2.9 ha (7.1 ac) of upland ditches, and a dredged reservoir system with a total area of 1.9 ha (4.8 ac). Drainage ditches are located along the roads and in the citrus groves. Sources of water in the ditches would include stormwater runoff, rainfall, and groundwater seepage. A discussion of the on-site wetlands is provided in Section 3.6.4. Wetland Resources.

3.5.1.2 Alternative 2

Surface waters on Alternative 2 (Phases A-E) are limited to 0.5 ha (1.3 ac) of roadside drainage ditches and a 1.7 ha (4.1 ac) dredged reservoir. As in Alternative 1, these drainage ditches are periodically flooded due to direct rainfall and surface and subsurface water flows towards them.

3.5.1.3 Phase F

Surface waters are not present within Phase F parcel boundaries.

3.5.2 Surface Water Quality

Surface waters at Alternative 1 and Alternative 2 are considered fresh waters with the primary sources being rainfall or groundwater. Stormwater runoff may also contribute to the ditches in the area. Waters associated with perched water table wetland systems will typically have low pH (< 6 units) as a result of acid soils, acid rainfall, organic acids from plant material decomposition, and dissolved CO_2 associated with plant respiration and the decomposition of plant materials. Dissolved oxygen values are typically below 5 mg/l but high primary production during periods of rapid plant growth can lead to saturation of dissolved oxygen levels on occasion. Total dissolved solids in perched water table systems at KSC typically range between 150 and 500 mg/l (Bionetics 1987). Wetlands often serve to increase water quality of adjacent surface water bodies. Wetland soils are effective at removing nitrate nitrogen, phosphorus and pollutants from surface runoff. The vegetative growth of wetlands slows the flow of surface water resulting in the deposition of coarse sediments. In low flow or standing water areas, finer particles of sediment would also be filtered out.

3.5.3 Groundwater Sources

KSC is a relatively flat, coastal area characterized by a near-surface water table. Since KSC is surrounded by brackish to saline surface water and nearly all of its groundwater originates as precipitation that infiltrates through soil into flow systems in the underlying geohydrologic units. Of the approximately 140 cm (55 in) of precipitation occurring annually, approximately 75 percent returns to the atmosphere through evapotranspiration. The remainder is accounted for by runoff, base flow, and recharge of the surficial aquifer.

There are three aquifer systems underlying KSC: the surficial aquifer system, the Intermediate aquifer system and the Floridan aquifer system (Figure 3-11, Table 3-9). The surficial aquifer system contains fresh water but is less extensive than the Floridan, the principal artesian aquifer in east-central Florida. The two main aquifers are separated by nearly impermeable confining units made up of three shallow aquifers called the Intermediate aquifer system (Edward E. Clark 1987).

The surficial aquifer can be divided into several subsystems (Figure 3-12). The Dune (Barrier Island) subsystem has a lens of freshwater less than 3 m (9.8 ft) thick on top of intruded saline water. The primary dune acts as the prime recharge area. Shallow groundwater flows east of the ridge to the Atlantic Ocean and west to Banana River, Mosquito Lagoon, or swales; at depth (> 6.1 m (20 ft)) flow is to the Atlantic Ocean. The Dune-Swale subsystem, in which the Alternative 2 site is located, includes high ridges with permeable sand that favor recharge. The dune/swale subsystem is the only area where the freshwater recharge of the deeper layers of the surficial aquifer occurs. During most of the year, shallow groundwater discharges to the swales. At the beginning of the rainy season after the spring drought, swales collect water and remain flooded; lateral and downward seepage from the swales helps to recharge the groundwater. In areas of pine flatwoods and swales, topography is lower and most soils have well-developed humic hardpans (spodic horizon, Bh layer) that restrict infiltration. During heavy rains, water perches above the hardpan and infiltrates slowly into the surficial aquifer, increasing evapotranspiration and reducing recharge relative to the prime recharge areas.

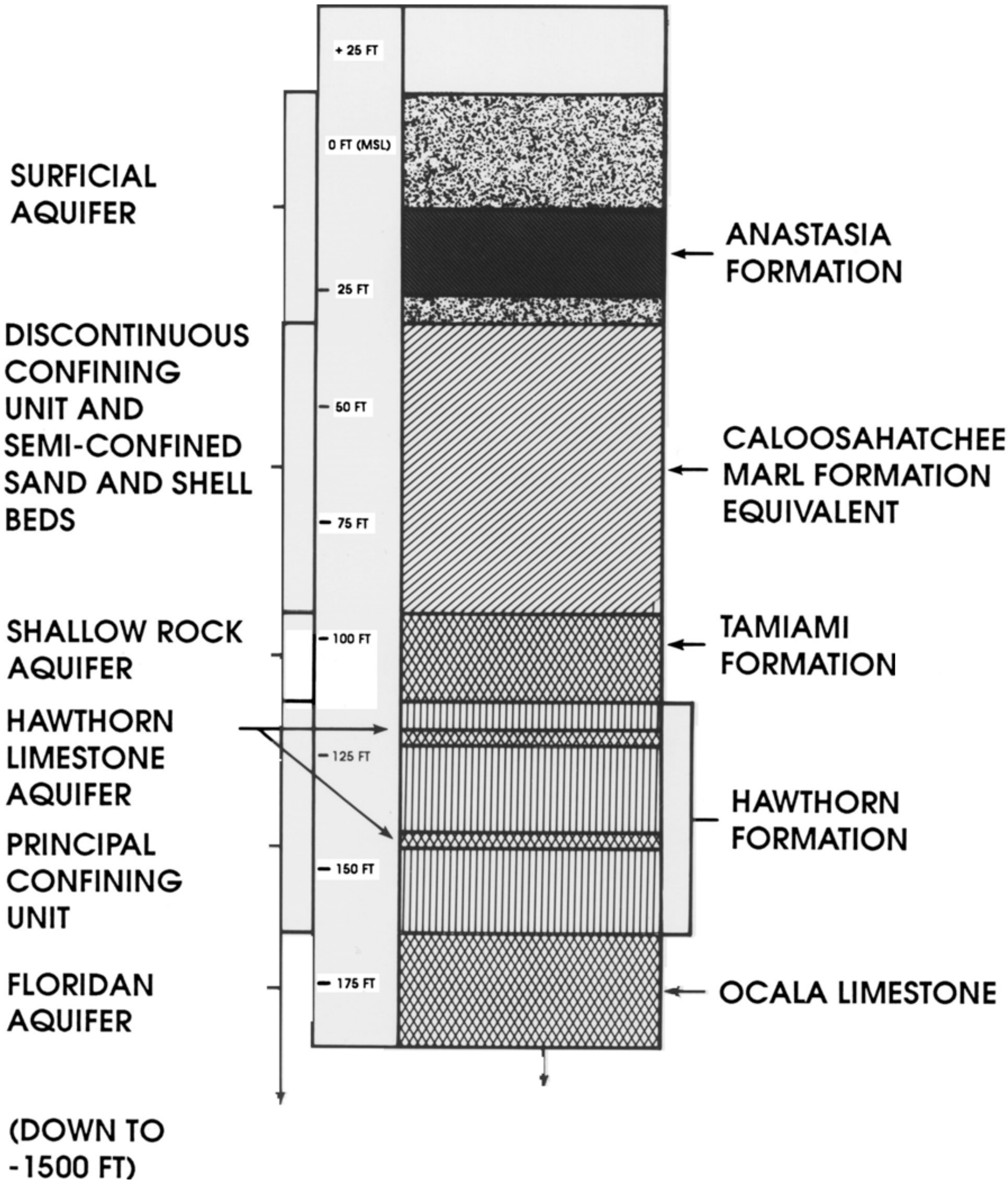

Figure 3-11. Geohydrological Units on Kennedy Space Center (redrafted from Edward E. Clark 1987).

Table 3-9. General Characteristics of the Aquifers on Kennedy Space Center[1]

Aquifer	**Geologic Strata**	**Recharge Area**	**Discharge Area**	**Water Quality**
Unconfined Water Table Aquifer				
Surficial Aquifer	Pleistocene and Recent deposits – sand, shell, coquina, silt, and marl	Rainfall and direct infiltration, particularly that on central sand ridges of island	Drainage canals and ditches; evapotranspiration including losses from swales; seepage to impoundments, lagoons, and ocean	Fresh in center of island, becomes mineralized toward lagoons and ocean
Secondary Artesian Aquifers				
Semi-artesian Shell and Sand Beds	Little freshwater recharge, may act as conduits for seawater intrusion		unknown	Moderately brackish, generally poorer than Florida aquifer
Shallow Rock Aquifer	Leakage upward from Florida aquifer	Tamiami Formation – shelly, partially consolidated quart sand and some limestone	unknown	Brackish
Hawthorn Limestone Aquifer	Leakage upward from Florida aquifer	Thin beds of weathered limestone, sandstone, and sand within the Hawthorn formation	unknown	Moderately brackish
Principal Artesian Aquifer				
Floridan Aquifer	Eocene limestones, Ocala Group, Avon Park formation	Central Florida- West Osceola, South Orange, and Polk Counties; Mims-Titusville ridge	Atlantic Ocean via offshore submarine springs, upward leakage where Hawthorn formation thins	Highly mineralized, primarily chlorides

[1] Data from Edward E. Clark (1987), table modified from Schmalzer and Hinkle (1990).

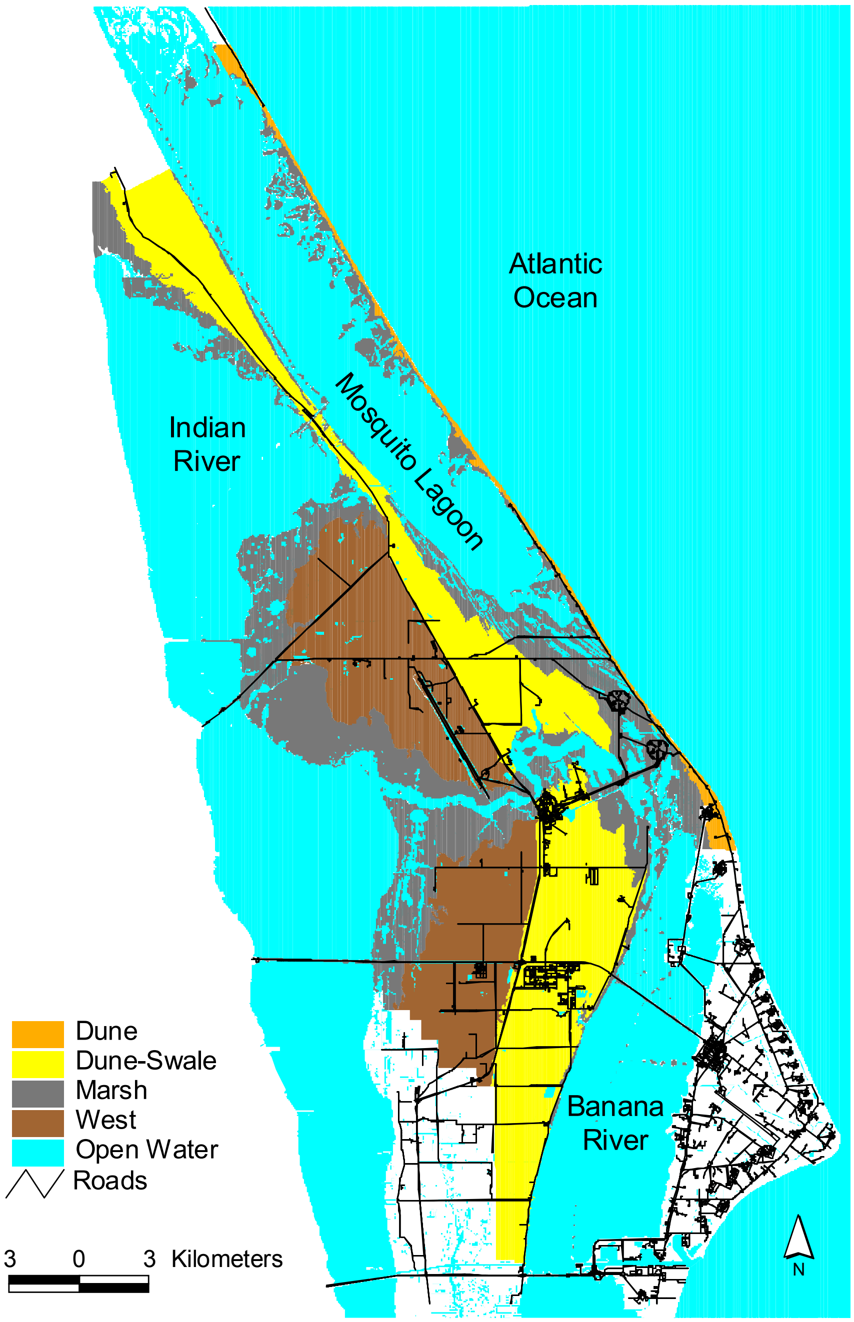

Figure 3-12. Groundwater Subaquifers of the Surficial Aquifer on Kennedy Space Center (from Schmalzer *et al.* 2000, modified from Edward E. Clark 1987).

In the West Plain and Marsh (Lowland) subsystems, the water table is typically within 0.9 m (2.95 ft) of the land surface, evapotranspiration losses are high, and the dispersed saline water interface renders water quality variable. The Alternative 1 site is located within this subsystem. In the West Plain south of Banana Creek, a lime rock "hardpan" replaces the humic hardpan of the Dune-Swale flatwoods. Along the coastlines, the surficial aquifer contacts the saline water of the Atlantic Ocean and the brackish lagoons. Seawater intrusion occurs as a wedge at the base of the surficial aquifer, since seawater is denser than fresh water. The position of the fresh-saline water interface fluctuates; when water levels are low, saline water moves inland, and when water levels are high, saline water is forced out, producing a dynamic system (Edward E. Clark 1987).

Recharge potential differs across KSC with the greatest recharge potential in the ridges of eastern Merritt Island and north of Haulover Canal (Figure 3-13). Groundwater mounds at the prime recharge areas. Groundwater flows from these recharge areas east toward the Banana River, Mosquito Lagoon, and the Atlantic Ocean and west toward the Indian River (Edward E. Clark 1987) (Figure 3-14). In general, water in the surficial aquifer system near the groundwater divide of the island has potential gradients which tend to carry some of the water vertically downward to the deepest part of the surficial aquifer system and potentially to the upper units of the Intermediate aquifer system (Edward E. Clark 1987) (Figure 3-14). Discharge for the surficial aquifer system occurs primarily from the estuarine lagoons, shallow seepage occurring to troughs and swales, and evapotranspiration (Edward E. Clark 1987).

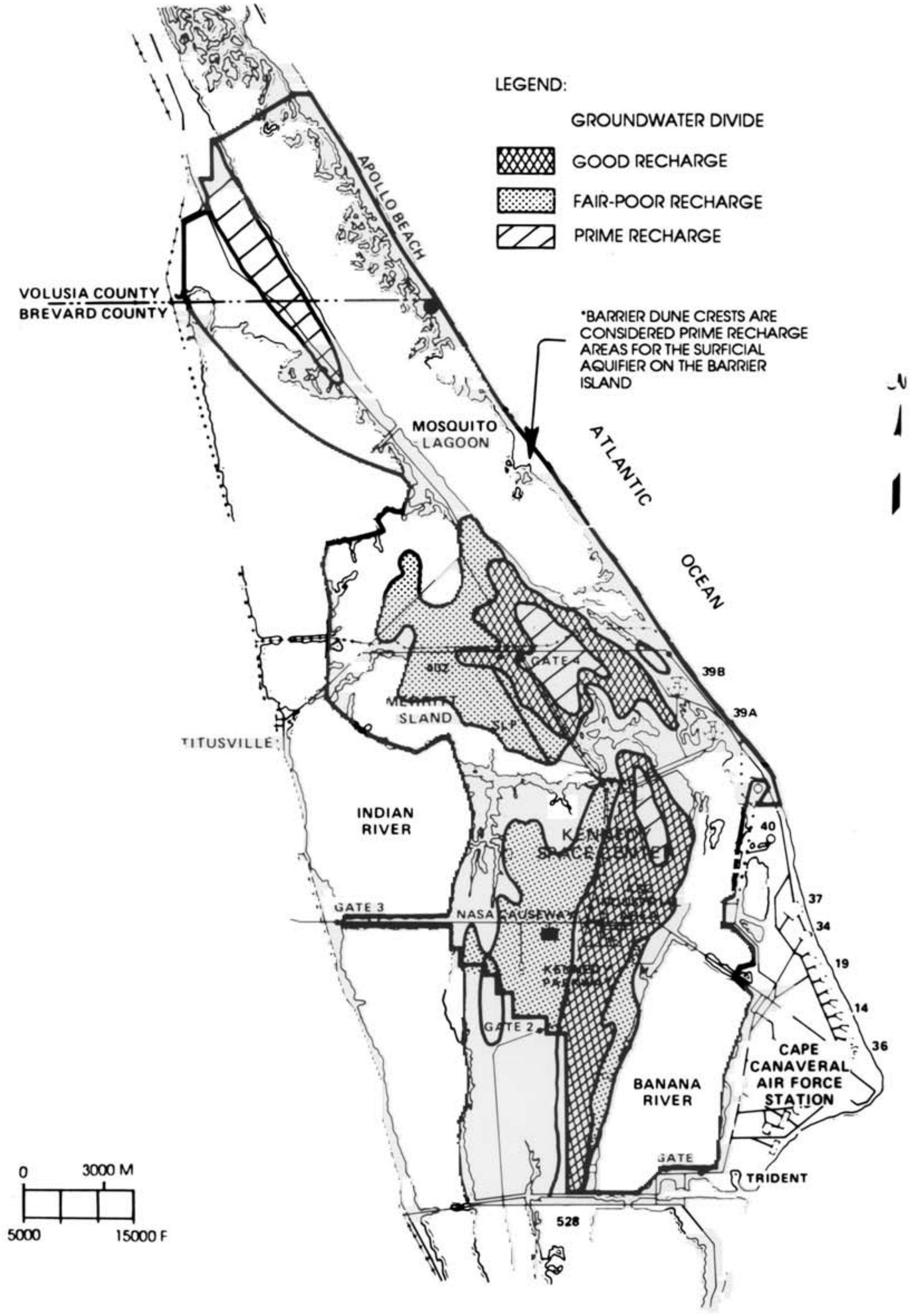

Figure 3-13. Potential for Recharge of the Surficial Aquifer (redrafted from Edward E. Clark 1987).

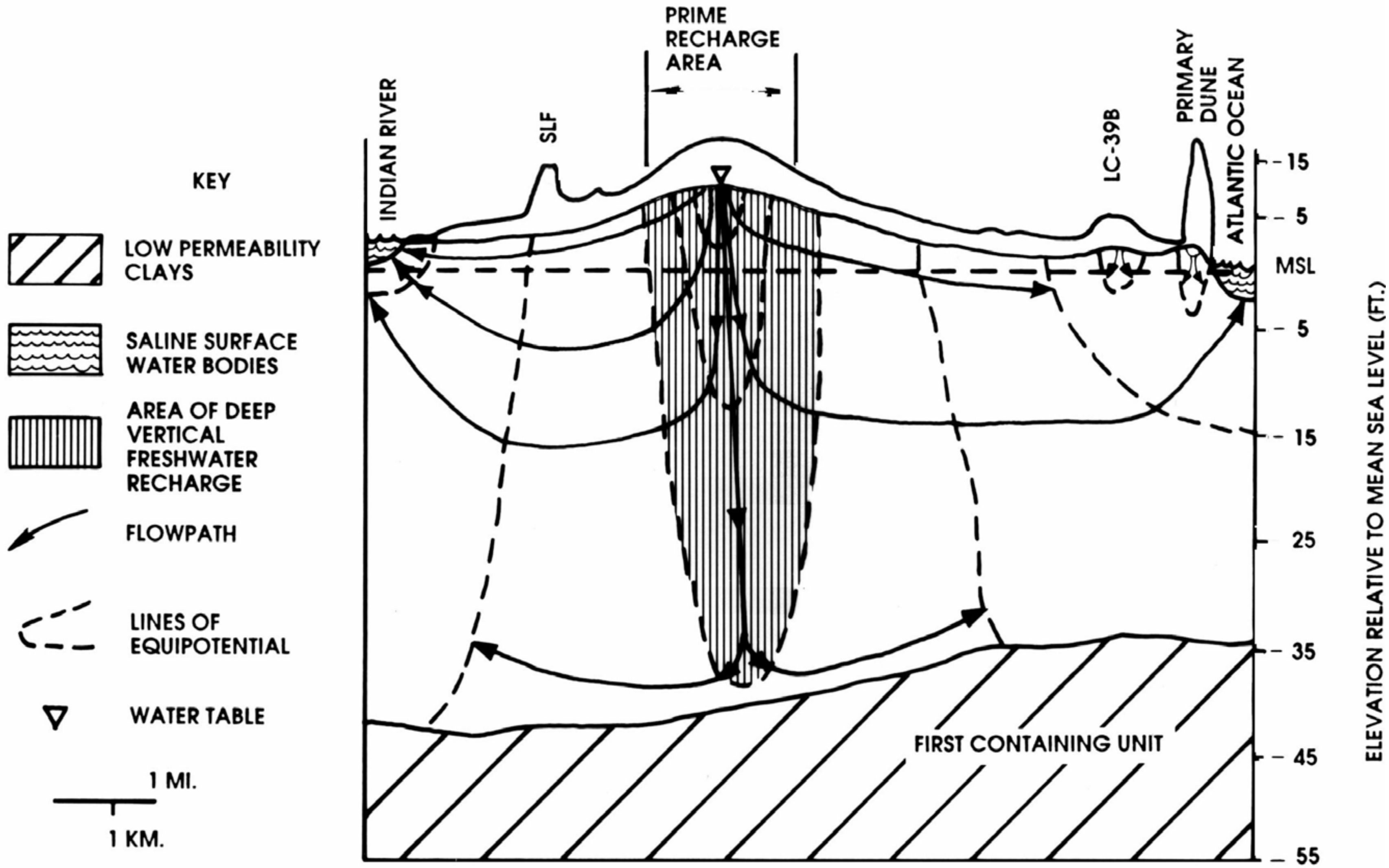

Figure 3-14. Groundwater Circulation in the Surficial Aquifer (redrafted from Edward E. Clark 1987).

Groundwater under artesian and semi-artesian conditions, the Floridan and Intermediate aquifer systems, have upward flow potentials. The great elevation differential between the Floridan aquifer system recharge areas (e.g., Polk and Orange Counties) and discharge areas along the Atlantic Coast provides the potential for the flowing artesian pressure experienced at KSC. Upward flow is limited by the thickness and the relatively impermeable nature of the confining units. Some upward flow may occur in the northwestern areas of KSC where the Hawthorn formation thins. In addition, there are cases of free-flowing and abandoned artesian wells that have allowed the deeper saline groundwater to impact the fresh surficial aquifer system. The general horizontal direction of flow in the Floridan aquifer system is northerly and northwesterly (Edward E. Clark 1987).

Recharge to the Intermediate aquifer system is dependent on leakage through the surrounding beds of lower permeability (Edward E. Clark 1987).

3.5.3.1 Alternative 1

Alternative 1 (Phases A-E) is located within the West Subaquifer of the surficial aquifers (Figure 3-12). This area has a fair to poor potential for recharge (Figure 3-13), because in the West Plain south of Banana Creek, a lime rock "hardpan" replaces the humic hardpan of the Dune-Swale flatwoods.

3.5.3.2 Alternative 2

Alternative 2 (Phases A-E) is found within the Dune-Swale Subaquifer of the surficial aquifers (Figure 3-12). The site is designated as a zone with good recharge potential to the surficial aquifer (Figure 3-13) and may contribute to the groundwater circulation on KSC.

3.5.3.3 Phase F

Phase F is also located within the West Subaquifer (Figure 3-12) and has fair to poor potential for recharge (Figure 3-13).

3.5.4 <u>Groundwater Quality</u>

The quality of water in an aquifer is dependent upon the lithology of the aquifer, the proximity of the aquifer to highly mineralized waters, the presence of residual saline waters in the aquifer, and the presence of chemical constituents in the aquifer and overlying soils.

3.5.4.1 Surficial Aquifer Systems

Unconsolidated, surficial aquifers are subject to contamination from point sources and from general land use. Contaminants may include trace elements, pesticides, herbicides, and other organics (Burkart and Kolpin 1993, Kolpin *et al.* 1995, 1998; Barbash *et al.* 1999). Urban and agricultural land uses have affected some Florida aquifers (Rutledge 1987, Barbash and Resek 1996). Point source contamination to the KSC surficial aquifer has occurred at certain facilities (Edward E. Edward E. Clark 1985, 1987a, 1987b).

Baseline conditions of the surficial aquifer have been studied recently in some detail (Schmalzer *et al.* 2000, Schmalzer and Hensley 2001). In the 2001 study, 6 sample sites were located in each subsystem of the surficial aquifer, 24 total sites. The sampling plan required installing a shallow well (4.6 m (15 ft)) at each site. Intermediate wells (10.7 m (32.1 ft)) were to be installed at 4 sites per subsystem (16 total). Deep wells (15.2 m (49.9 ft)) were to be installed at 3 sites per subsystem (12 total). A total of 51 wells were installed at varying depths. Groundwater samples were collected using standard protocols. Groundwater samples were analyzed for organochlorine pesticides, aroclors, chlorinated herbicides, polynuclear aromatic hydrocarbons (PAH), total metals, dissolved oxygen (DO), turbidity, pH, specific conductivity, temperature, total dissolved solids (TDS), and total organic carbon (TOC).

The baseline data, summarized in Table 3-10, suggest that widespread contamination of the surficial aquifer on KSC has not occurred. No organochlorine pesticides, aroclors, or chlorinated herbicides occurred above laboratory detection limits. Although pesticide residues or degradation products and chlorinated herbicides occurred in some soils, those concentrations were low and migration into the aquifer either has not occurred or has not been widespread. Some PAHs occurred in the shallow wells. PAHs occur in a variety of KSC soils at relatively low concentrations. Some occurrence of PAHs in shallow wells is not surprising since PAHs have both natural and anthropogenic sources (e.g., Suess 1976, Standley and Simoneit 1987, Jones *et al.* 1989a, b).

Most trace metals were in low concentrations in KSC groundwater, if they occurred above detection levels. These findings are consistent with the low concentrations of most trace metals in KSC soils and the primarily quartz composition of the terrigenous deposits comprising the surficial sediments of Merritt Island (Brown *et al.* 1962, Milliman 1972, Field and Duane 1974). Aluminum (Al), iron (Fe), and manganese (Mn) occurred above detection limits more frequently than other trace metals. Al and Fe are abundant components in the Earth's crust and are present in KSC soils. Intense leaching, particularly in acid scrub and flatwoods soils, mobilizes Al and Fe (Paton *et al.* 1995). Iron is a typical constituent of groundwater in the surficial aquifer in Florida (Miller 1997). Manganese is one of the most abundant trace elements (Kabata-Pendias and Pendias 1984); it is present in KSC soils but the concentrations are relatively low. Solution and precipitation of Fe and Mn are affected by pH and oxidation-reduction conditions.

The chemical parameters varying most with subaquifer and depth were calcium (Ca), chloride (Cl^-), magnesium (Mg), potassium (K), and sodium (Na), as well as, conductivity and TDS that are related to these cations and anions. The trends were generally consistent among these; the shallow wells in the Dune-Swale subaquifer had the lowest values. Concentrations increased with depth within a subaquifer. At a given depth, concentrations in the Dune-Swale and West Plain subaquifers were lower than in the Dune and Marsh subaquifers. These trends reflect increased mineralization with depth and differences between the fresh water Dune-Swale and West Plain subaquifers and the more saline Dune and Marsh systems. The Dune and Marsh subaquifers interact with saline water of the Atlantic Ocean and Indian River Lagoon system, respectively (Edward E. Clark 1987 figure 3-15).

3.5.4.2 Intermediate Aquifer System

The groundwater quality in the intermediate aquifer system varies from moderately brackish to brackish due to its recharge by upward leakage from the highly mineralized and artesian Floridan aquifer system and in some cases from lateral intrusion from the Atlantic Ocean (Edward E. Clark 1987). Groundwater in the semi-artesian Sand and Shell aquifer is brackish. Groundwater in the Shallow Rock aquifer is brackish with some sites receiving seawater intrusion. The limited data that exists for the relatively thin Hawthorn Limestone aquifer indicate that the aquifer is moderately brackish (Edward E. Clark 1987).

Table 3-10. Chemical Parameters in Groundwater by Subaquifer and Depth

Parameter	**All Ground-water**	**Dune Shallow**	**Dune Inter-mediate**	**Dune Deep**	**Dune-Swale Shallow**	**Dune-Swale Inter-mediate**	**Dune-Swale Deep**	**West Shallow**	**West Inter-mediate**	**West Deep**	**Marsh Shallow**	**Marsh Inter-mediate**	**Marsh Deep**
Sample Size	57	6	5	3	7	4	3	7	5	3	7	5	2
PAHs													
Benzo(a)anthracene (ug/L)	0.035 (0.02)	0.047 (0.041)	0.03 nd	0.03 nd	0.036 (0.015)	0.03 nd	0.03 nd	0.051 (0.048)	0.03 nd	0.03 nd	0.03 nd	0.03 nd	0.03 nd
Benzo(a)pyrene (ug/L)	0.029 (0.017)	0.031 (0.014)	0.025 nd	0.025 nd	0.031 (0.013)	0.026 nd	0.027 nd	0.048 (0.044)	0.025 nd	0.025 nd	0.025 nd	0.025 nd	0.025 nd
Benzo(b)fluoranthene (ug/L)	0.05 (0.02)	0.05 nd	0.05 nd	0.05 nd	0.051 nd	0.053 nd	0.053 nd	0.067 (0.045)	0.05 nd	0.05 nd	0.05 nd	0.05 nd	0.05 nd
Benzo(k)fluoranthene (ug/L)	0.028 (0.019)	0.037 (0.019)	0.025 nd	0.025 nd	0.026 nd	0.026 nd	0.027 nd	0.036 (0.028)	0.025 nd	0.025 nd	0.025 nd	0.025 nd	0.025 nd
Chrysene (ug/L)	0.03 (0.03)	0.05 (0.06)	0.025 nd	0.025 nd	0.031 (0.013)	0.026 nd	0.027 nd	0.046 (0.055)	0.025 nd	0.025 nd	0.025 nd	0.025 nd	0.025 nd
Fluoranthene (ug/L)	0.06 (0.08)	0.05 nd	0.05 nd	0.05 nd	0.06 (0.03)	0.053 nd	0.053 nd	0.14 (0.23)	0.05 nd	0.05 nd	0.05 nd	0.05 nd	0.05 nd
Indeno(1,2,3-cd) pyrene (ug/L)	0.03 (0.01)	0.04 (0.03)	0.025 nd	0.025 nd	0.026 nd	0.026 nd	0.027 nd	0.034 (0.025)	0.025 nd	0.025 nd	0.025 nd	0.025 nd	0.025 nd

Data are means with standard deviations in parentheses.
Field parameters were not measured on replicate samples.
nd = indicates all samples below detection limits (Schmalzer *et al.* 2000, Schmalzer and Hensley 2001).

Table 3-10. (continued)

Parameter	All Ground-water	Dune Shallow	Dune Inter-mediate	Dune Deep	Dune-Swale Shallow	Dune-Swale Inter-mediate	Dune-Swale Deep	West Shallow	West Inter-mediate	West Deep	Marsh Shallow	Marsh Inter-mediate	Marsh Deep
Elements													
Aluminum (mg/L)	0.16 (0.27)	0.083 (0.098)	0.105 (0.025)	0.05 (0.04)	0.298 (0.481)	0.117 (0.136)	0.049 (0.041)	0.143 (0.175)	0.057 (0.054)	0.033 (0.014)	0.44 (0.50)	0.15 (0.08)	0.066 (0.020)
Antimony (mg/L)	0.003 (0.002)	0.003 nd	0.007 (0.004)	0.0025 nd	0.0025 nd	0.0025 nd	0.0053 (0.0049)	0.0025 nd	0.0025 nd	0.0025 nd	0.0038 (0.0025)	0.0045 nd	0.0025 nd
Arsenic (as carcinogen) (mg/L)	0.011 (0.016)	0.015 (0.02)	0.028 (0.039)	0.021 (0.014)	0.005 nd	0.005 nd	0.005 nd	0.006 (0.002)	0.008 (0.007)	0.005 nd	0.025 (0.029)	0.005 nd	0.005 nd
Barium (mg/L)	0.06 (0.05)	0.05 nd	0.05 nd	0.05 nd	0.05 nd	0.05 nd	0.05 nd	0.05 nd	0.05 nd	0.05 nd	0.11 (0.13)	0.06 (0.03)	0.05 nd
Beryllium (mg/L)	0.0005 (0.0003)	0.0005 nd	0.001 (0.001)	0.0005 nd	0.0005 nd	0.0005 nd	0.0005 nd	0.0005 nd	0.0005 nd	0.0005 nd	0.0005 nd	0.0005 nd	0.0005 nd
Cadmium (mg/L)	0.0007 (0.0011)	0.0008 (0.0006)	0.002 (0.004)	0.0007 (0.0003)	0.0006 (0.0002)	0.0005 nd	0.0005 nd	0.0005 nd	0.0005 nd	0.0005 nd	0.0005 nd	0.0005 nd	0.0005 nd
Calcium (mg/L)	242.4 (201.2)	148.8 (75.5)	322.4 (189.2)	336.7 (200.3)	56.1 (43.6)	97.6 (74.4)	254.0 (265.7)	144.3 (51.3)	192.0 (47.6)	246.7 (73.7)	262.7 (238.9)	594.0 (98.4)	620.0 (70.7)
Chloride (mg/L)	4545 (7272)	2995 (4114)	12340 (8322)	7433 (7420)	27 (33)	102 (139)	3707 (6316)	404 (669)	1099 (618)	1127 (1016)	4251 (3293)	14860 (11870)	14800 (15839)
Chromium (total) (mg/L)	0.006 (0.003)	0.005 nd	0.006 (0.002)	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.009 (0.007)	0.005 nd	0.005 nd
Copper (mg/L)	0.031 (0.035)	0.025 nd	0.04 (0.03)	0.025 nd	0.025 nd	0.025 nd	0.025 nd	0.025 nd	0.025 nd	0.110 (0.147)	0.022 (0.006)	0.028 (0.006)	0.025 nd
Iron (mg/L)	1.12 (1.76)	0.058 (0.08)	0.77 (0.99)	2.06 (3.24)	0.36 (0.59)	1.28 (0.53)	1.21 (1.50)	0.81 (0.94)	1.60 (0.20)	2.00 (0.97)	1.60 (3.71)	2.31 (2.38)	1.21 (1.68)

Data are means with standard deviations in parentheses.
Field parameters were not measured on replicate samples.
nd = indicates all samples below detection limits (Schmalzer *et al.* 2000, Schmalzer and Hensley 2001).

Table 3-10. (continued)

Parameter	**All Ground-water**	**Dune Shallow**	**Dune Inter-mediate**	**Dune Deep**	**Dune-Swale Shallow**	**Dune-Swale Inter-mediate**	**Dune-Swale Deep**	**West Shallow**	**West Inter-mediate**	**West Deep**	**Marsh Shallow**	**Marsh Inter-mediate**	**Marsh Deep**
Elements (cont.)													
Lead (mg/L)	0.004 (0.005)	0.0025 nd	0.009 (0.10)	0.004 (0.003)	0.0025 nd	0.0025 nd	0.0025 nd	0.0025 nd	0.0025 nd	0.011 (0.015)	0.003 (0.001)	0.006 (0.005)	0.0025 nd
Magnesium (mg/L)	307.4 (493.8)	201.1 (267.6)	847.6 (571.1)	1036.7 (845.6)	2.2 (2.6)	10.0 (13.5)	244.9 (420.1)	32.6 (31.7)	73.0 (19.4)	98.7 (28.7)	248.6 (211.6)	796.8 (734.0)	782.5 (1014.7)
Manganese (mg/L)	0.068 (0.098)	0.02 (0.023)	0.075 (0.072)	0.114 (0.162)	0.015 (0.026)	0.022 (0.02)	0.057 (0.08)	0.024 (0.095)	0.046 (0.019)	0.070 (0.007)	0.062 (0.079)	0.284 (0.146)	0.141 (0.112)
Nickel (mg/L)	0.006 (0.004)	0.005 nd	0.006 (0.003)	0.007 (0.003)	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.015 (0.014)	0.005 nd	0.005 nd	0.005 nd
Potassium (mg/L)	89.2 (150.6)	66.0 (91.3)	274.2 (177.6)	316.7 (211.3)	1.1 (0.6)	1.2 (1.7)	31.5 (54.1)	8.1 (8.1)	17.0 (13.2)	13.3 (0.6)	74.8 (63.7)	215.6 (241.7)	239.4 (326.2)
Selenium (mg/L)	0.006 (0.007)	0.005 nd	0.01 (0.01)	0.02 nd	0.007 (0.003)	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.005 nd
Silver (mg/L)	0.005 (0.007)	0.005 nd	0.005 nd	0.007 (0.003)	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.005 nd
Sodium (mg/L)	2670 (4011)	1510 (2011)	6720 (4342)	8167 (6526)	13.1 (11.9)	53.6 (59.5)	1875 (3226)	240 (318)	560 (399)	883 (196)	3121 (3030)	7360 (5280)	6650 (7566)
Thallium (mg/L)	0.001 (0.0005)	0.001 nd	0.001 nd	0.001 nd	0.001 nd	0.001 nd	0.001 (0.0006)	0.001 nd	0.001 (0.0005)	0.001 nd	0.001 (0.0008)	0.001 (0.002)	0.002 (0.001)
Vanadium (mg/L)	0.005 (0.002)	0.005 nd	0.007 (0.004)	0.005 nd	0.005 nd	0.005 nd	0.005 nd	0.006 (0.002)	0.005 nd	0.005 nd	0.007 (0.003)	0.005 nd	0.005 nd
Zinc (mg/L)	0.053 (0.024)	0.05 nd	0.05 nd	0.05 nd	0.05 nd	0.05 nd	0.05 nd	0.05 nd	0.05 nd	0.11 (0.10)	0.05 nd	0.05 nd	0.05 nd

Data are means with standard deviations in parentheses.
Field parameters were not measured on replicate samples.
nd = indicates all samples below detection limits (Schmalzer *et al.* 2000, Schmalzer and Hensley 2001).

Table 3-10. (continued)

Parameter	All Ground-water	Dune Shallow	Dune Inter-mediate	Dune Deep	Dune-Swale Shallow	Dune-Swale Inter-mediate	Dune-Swale Deep	West Shallow	West Inter-mediate	West Deep	Marsh Shallow	Marsh Inter-mediate	Marsh Deep
Other Parameters													
Total Dissolved Solids (mg/L)	8066 (11275)	5455 (6845)	21564 (13441)	22133 (19535)	156 (86)	608 (463)	6987 (11270)	1164 (1298)	2760 (1228)	3900 (1375)	8214 (5227)	19020 (13951)	21050 (22557)
Total Organic Carbon (mg/L)	18.9 (23.4)	1.8 (1.3)	4.7 (7.5)	11.8 (15.1)	19.1 (18.0)	6.5 (4.1)	12.3 (2.5)	31.4 (30.0)	9.2 (8.9)	7.3 (3.5)	51.3 (35.5)	26.4 (18.9)	15.5 (6.4)
Sample Size (field)	51	6	4	3	6	4	3	6	4	3	6	4	2
Hydrogen Ion	8.80E-6 (5.46E-5)	3.49E-8 (2.46E-8)	4.41E-8 (4.27E-8)	7.34E-8 (8.35E-8)	7.40E-5 (1.55E-4)	1.25E-7 (4.91E-8)	1.06E-7 (7.97E-8)	1.09E-7 (4.29E-8)	6.16E-8 (4.93E-8)	1.04E-7 (1.38E-9)	2.13E-7 (2.62E-7)	1.55E-7 (4.00E-8)	5.20E-8 (2.89E-8)
Ph	5.06	7.46	7.36	7.13	4.13	6.90	6.97	6.96	7.21	6.98	6.67	6.80	7.28
Dissolved Oxygen (mg/L)	1.82 (1.44)	2.79 (1.24)	1.97 (1.10)	2.88 (2.78)	1.57 (0.83)	2.23 (1.42)	3.27 (2.55)	1.00 (0.64)	0.51 (0.37)	1.18 (0.16)	2.21 (1.48)	0.76 (0.50)	1.79 (2.40)
Temperature (C)	25.7 (1.3)	26.8 (0.8)	26.2 (0.6)	26.0 (0.3)	26.7 (1.1)	24.8 (0.5)	26.1 (1.4)	25.7 (1.1)	24.1 (0.9)	23.1 (0.2)	26.9 (0.5)	24.9 (0.2)	24.9 (1.8)
Specific Conductivity (umhos/cm)	10012 (13156)	6607 (7368)	24875 (18001)	22507 (18314)	267 (171)	872 (620)	7037 (10880)	2242 (2119)	3715 (1482)	5770 (1440)	11897 (7147)	27210 (18546)	25955 (23257)

Data are means with standard deviations in parentheses.
Field parameters were not measured on replicate samples.
nd = indicates all samples below detection limits (Schmalzer *et al.* 2000, Schmalzer and Hensley 2001).

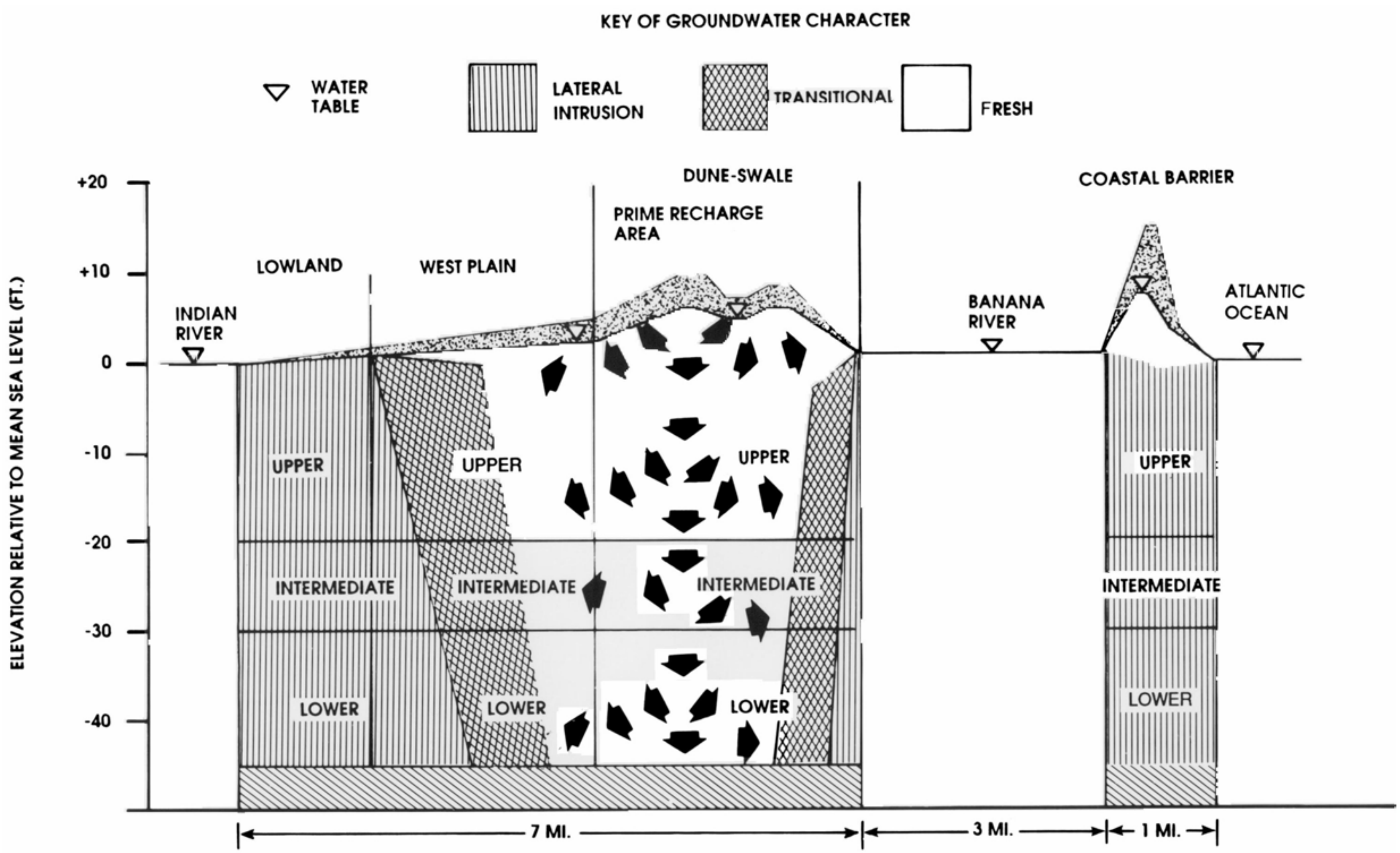

Figure 3-15. Chemical Evolution of Groundwater in the Surficial Aquifer (redrafted from Clark 1987).

3.5.4.3 Floridan Aquifer System

The Floridan aquifer system at KSC contains highly mineralized water with high concentrations of chlorides due to the fact that seawater was trapped in the aquifer when it formed. The high concentrations of chlorides can also be explained to a lesser degree by induced lateral intrusion (due to inland pumping) and a lack of flushing due to a low proximity to freshwater recharge areas (Clark 1987).

3.6 BIOLOGICAL RESOURCES

This section provides a general overview of the biological resources at KSC and site-specific information on the terrestrial, wetland, and aquatic resources and threatened and endangered species occurring at each of the ISRP alternative sites.

3.6.1 Methodology

Information for this section was derived largely from results of biological studies previously conducted at KSC.

Fieldwork was conducted on-site to verify and fill gaps in existing data and to provide additional information about the existing resources in the study areas. Specifically, biologists with Jones, Edmunds & Associates, Inc. (JEA) performed wetland delineations on the Alternative 1 (Phases A-F) site in January 2002. To document wildlife use, they performed two morning and two evening pedestrian survey events, each approximately 2.5 hrs in duration, on the subject sites during the time period May 22-24, 2002. Dynamac Corporation biologists completed wetland delineations on the Alternative 2 (Phases A-E) site on January 23, 2003. Two (2) pedestrian survey events, each approximately 5 hrs in duration, were performed on January 30, 2003 and March 7, 2003 to qualitatively document wildlife use and to verify existing habitat use data for Florida Scrub-jays and population density data for gopher tortoises (*Gopherus polyphemus)*.

The wetland delineations were conducted in accordance with methods specified in the Technical Report Y-87-1, *Corps of Engineers Wetlands Delineation Manual* (January 1987) and State of Florida's (State) *Delineation of the Landward Extent of Wetlands and Surface Waters* (Chapter 62-340, FAC). USACE and SJRWMD representatives verified the results of the wetland delineations conducted on Alternative 1 (Phases A-F) on January 28, 2002 (JEA 2002). The USACE representative verified wetland delineations conducted on the Alternative 2 (Phases A-E) site on February 18, 2003, and the SJRWMD representative did so on March 6, 2003. Letters to the USACE and SJRWMD requesting verification of the wetland determinations were sent by NASA EPO in May 2003 and are included for reference in Appendix H. These letters detail the extent of Federal and State wetland jurisdiction for the Alternative 1 and Alternative 2 sites.

The existing land use for the Alternative 1 and Alternative 2 sites was classified using Level IV of the Florida Land Use, Cover and Forms Classification System (FLUCCS) (Florida Department of Transportation (FDOT) 1999). The FLUCCS classification system, based on land use, predominant vegetative composition, and landform, is a widely used standardized method. The FLUCCS classification system broadly describes the predominant natural communities occurring in Florida. It does not attempt to accurately describe the multiple natural community variations that are exhibited for a specific community type across the landscape within the State. Therefore, the FLUCCS classification type that best describes the general vegetative and hydrological condition of the natural community under consideration was selected.

3.6.2 General Overview of Biological Resources of the KSC

The MINWR and CNS buffer lands on KSC provide for the greatest wildlife diversity among Federal facilities in the continental United States (Breininger *et al*. 1994). Such diversity is partially attributable to the location of KSC within a biogeographical transition zone, having faunal and floral assemblages derived from both temperate Carolinian and tropical/subtropical Caribbean biotic provinces (Robertson 1955, Boyles 1966, Ehrhart 1976, Sweet *et al.* 1979, Greller 1980, Snelson 1976, Stout 1979, Gilmore *et al.* 1981, Provancha *et al.* 1986, Virnstein and Campbell 1987, DeFreese 1991). KSC's location within the Merritt Island/Cape Canaveral/Turnbull ecosystem within the IRL watershed, proximity to the coast, and abundance of migratory birds further contribute to the regional species diversity found on KSC (Breininger *et al.* 1994). The Merritt Island/Cape Canaveral/Turnbull ecosystem, in conjunction with the nearby St. Johns River Basin ecosystem, provides biological corridors between temperate Carolinian and tropical/subtropical Caribbean provinces (Breininger *et al.* 1994).

Detailed vegetation maps for KSC show scrub and pine flatwoods as the dominant upland communities (Provancha *et al.* 1986). Fresh and salt marshes occur adjacent to the estuary and in low areas interspersed among scrub and pine flatwoods (Schmalzer and Hinkle 1985). Forests occur on higher areas among marshes and lower areas among scrub and pine flatwoods (Breininger *et al.* 1994). Scrub and pine flatwoods on KSC support the largest population of Florida Scrub-Jay along the Atlantic Coast (Cox 1987, Breininger 1989, Breininger *et al.* 1994, Breininger *et al.* 1996, Breininger 2001). Additionally, no other habitat on KSC has more endangered or potentially endangered wildlife species as permanent residents (Breininger *et al.* 1994).

Breininger (1985) prepared a comprehensive assessment of the status of endangered and potentially endangered wildlife (amphibians, reptiles, birds, and mammals) on KSC, including the relative occurrence by habitat and a bibliography of wildlife habitat associations applicable to KSC. This document, updated in 1994 (Breininger *et al.* 1994), evaluated the current biology and regional ecology of 119 resident or migratory wildlife species that are endangered or declining and may occur on KSC. Breininger *et al.* (1994) also reviewed threats to biological diversity on KSC, noting that small population sizes, population isolation, ecosystem and habitat fragmentation, road mortality, and other edge effects may represent more critical threats to biological diversity than traditional impacts of habitat loss and contamination resulting from construction.

3.6.3 Terrestrial Resources

This subsection describes existing terrestrial resources occurring on Alternative 1 (Phases A-E), Alternative 2 (Phases A-E), and the Phase F parcel based on predominant vegetative cover. Man-made structures or artificial upland features are also identified in this subsection. Wetlands are intermediaries between terrestrial and aquatic resources, sharing some of the same features of both, and thus are separately considered below in Section 3.6.4. Wetland Resources.

A description of the predominant flora characterizing each community type identified on the study sites is provided in Appendix I. The importance of these terrestrial communities as habitat to threatened and endangered floral and faunal species is discussed below in Section 3.6.6.

3.6.3.1 Alternative 1

Citrus groves (FLUCCS–2211) cover 78 percent (100 ha (246 ac)) of the Alternative 1 (Phases A-E) site. Remaining land features are wetland community types and artificial open waters and ditches constructed to support the citrus operations. These resources are discussed below. Unaltered upland habitat types are absent from the Alternative 1 (Phases A-E) site. Figure 3-16 provides an existing land use map for the Alternative 1 site.

3.6.3.2 Alternative 2

The Alternative 2 (Phases A-E) site is generally characterized as a scrubby pine flatwoods matrix with slightly elevated oak scrub ridges and numerous freshwater wetland swales oriented north to south. The majority of the Alternative 2 site is undisturbed natural habitat. Upland community types classified on this site are Scrubby Pine Flatwoods (FLUCCS-4111), Oak Scrub (FLUCCS-4210), and Disturbed Scrubby Flatwoods (FLUCCS-7400). The disturbed scrubby flatwoods area was historically cleared and is naturally regenerating with primarily native flatwood plant species. However, exotic plant species, including Brazilian pepper (*Schinus terebinthifolius*) and Napier grass (*Pennisetum purpureum*), have become established within this area as a result of disturbance during past land clearing. The upland habitat areas on Alternative 2 occupy 99.4 ha (245.6 ac).

Two dirt land management roads (Roads and Highways Graded and Drained (FLUCCS-8145) are located within the Alternative 2 project boundaries. These roads occupy 1.4 ha (3.6 ac). An existing land use map for the Alternative 2 (Phases A-E) site is provided in Figure 3-17. A Government Building (FLUCCS-1750) and the B Ave SW (Tel-4 Road) right-of-way (Government Maintained Road (FLUCCS-8144)) border on the western boundary of Alternative 2.

3.6.3.3 Phase F

Citrus groves (FLUCCS-2211) comprise 77 percent (7.6 ha (8.8 ac)) of the Phase F parcel. Within the northern one-half of this parcel is located a 1.8 ha (4.5 ac) remnant Pine-Mesic Oak (FLUCCS-4140) forest. The existing land use map for the Phase F parcel is shown on Figure 3-16.

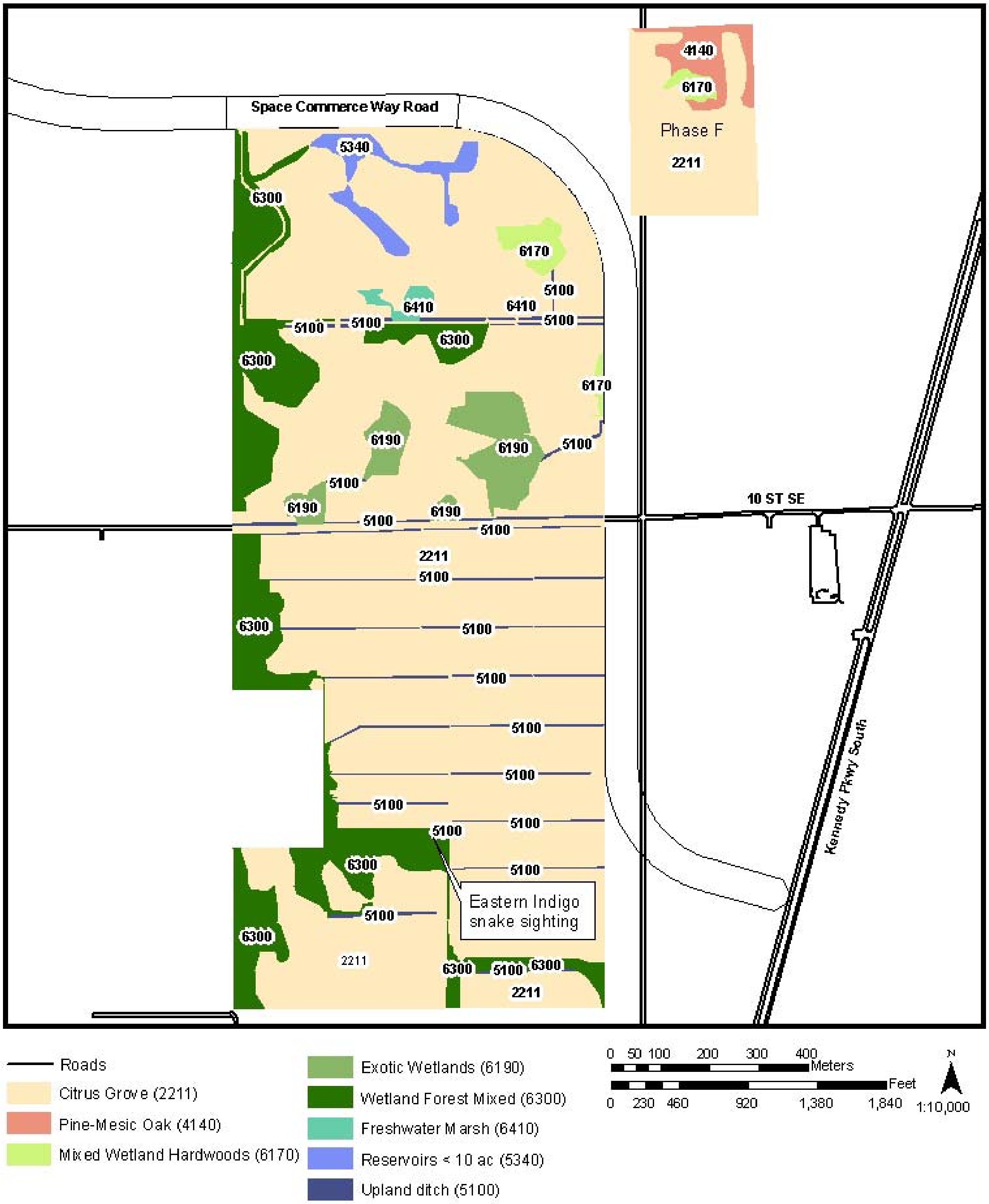

Figure 3-16. Existing Land Use of Alternative 1 and Phase F.

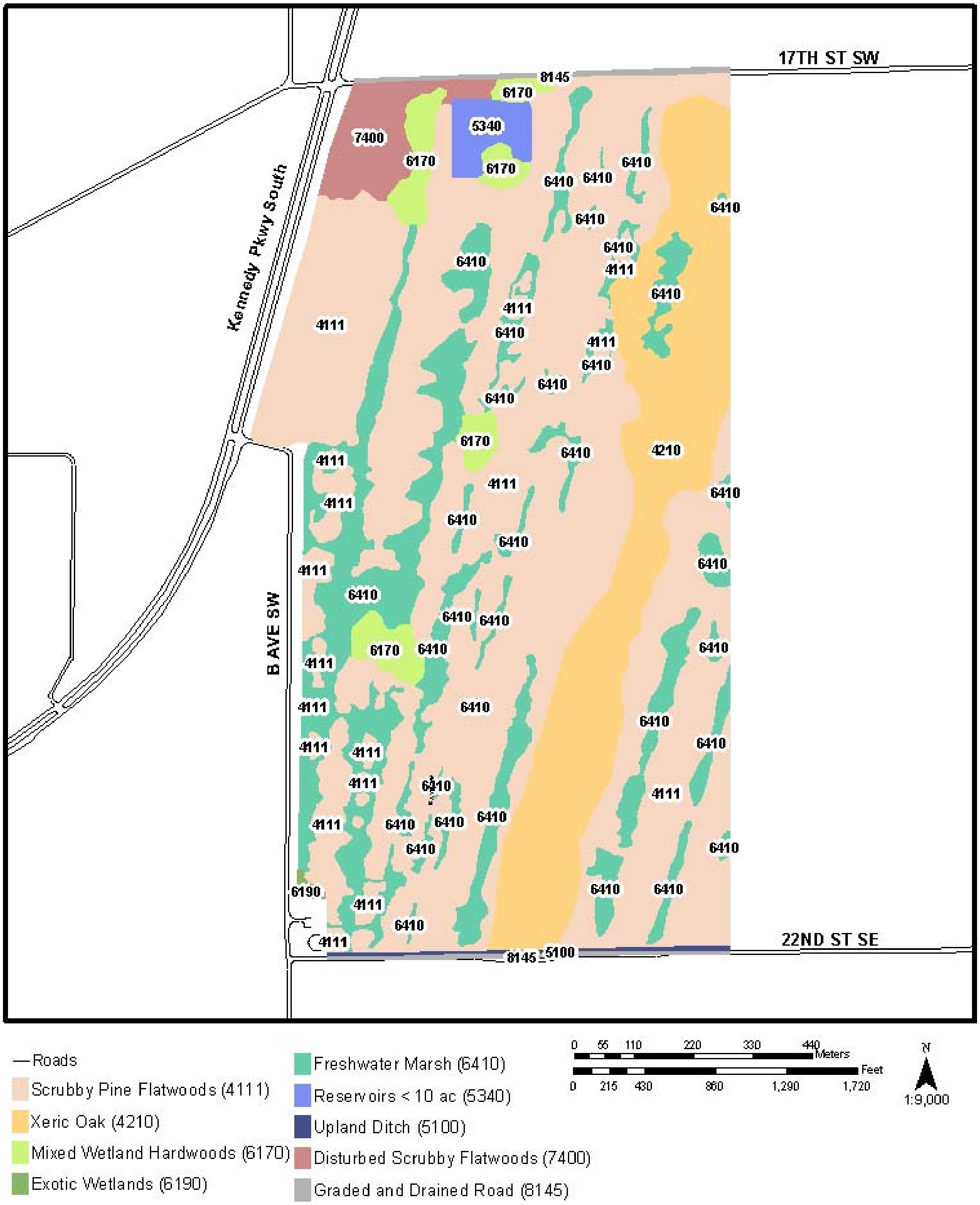

Figure 3-17. Existing Land Use of Alternative 2 Not Showing Phase F.

3.6.4 Wetland Resources

3.6.4.1 Alternative 1

Wetland resources identified on the Alternative 1 (Phases A-E) site are Mixed Wetland Hardwoods (FLUCCS-6170), Wetland Forest Mixed (FLUCCS-6300), Exotic Wetland Hardwoods-Brazilian pepper (FLUCCS-6190), and Freshwater Marsh (FLUCCS-6410). Wetland community types comprise a total of 23.3 ha (57.6 ac) (Figure 3-16).

Almost 30 percent of the on-site wetlands, or 6.4 ha (15.8 ac), are embedded within the citrus groves. The loss of native upland community types surrounding wetlands often results in indirect impacts to the functional attributes of the wetland. Wetland functions most threatened by the loss of the bordering upland habitat are water quantity and quality, energy and nutrient systems, and wildlife habitat (Taylor *et al*. 1999). This loss of wetland function is exemplified on the Alternative 1 (Phases A-E) site where the extensive agricultural drainage system has altered the local groundwater hydrology causing significant changes in structure and composition of the wetland communities found within the citrus groves. The 4.6 ha (11.4 ac) of wetlands designated as Exotic Wetlands (FLUCCS-6190) on this site, are essentially a monoculture of Brazilian pepper. Native floras have been completely displaced by this exotic pest plant causing a significant reduction in the habitat value of these wetlands to native wildlife. Brazilian pepper has also infested the Mixed Wetland Hardwood (FLUCCS-6170) communities with remnant native hardwoods, primarily red maple (*Acer rubrum*), persisting. Impacts from the agricultural development on the Alternative 1 site to the 16.9 ha (41.8 ac) of Wetland Forest Mixed (FLUCCS-6300) bordering the western property boundary appear to have been minimized by the intact linkage of these wetlands to the undisturbed landscape to the west. Negative boundary effects, mainly the colonization by exotic and weedy species along the disturbed edge of this wetland community, were observed.

3.6.4.2 Alternative 2

High quality freshwater swale marshes are common on the Alternative 2 (Phases A-E) site. These wetlands have historically formed within the shallow depressional swales located between the low ridges occupied by the scrub and pine flatwood communities. Wetland community types classified on the site are Freshwater Marsh (FLUCCS-6410), Mixed Wetland Hardwoods (FLUCCS-6170), and a 0.2 ha (0.4 ac) Exotic Wetlands-Brazilian pepper (FLUCCS-6190) patch (Figure 3-17). The freshwater swale marshes are the primary wetland habitat type covering 22.9 ha (56.5 ac) of the Alternative 2 (Phases A-E) site. The mixed wetland hardwoods, comprising 4.0 ha (10.0 ac), have developed in deeper pockets within the swales that are flooded for longer periods of time. The Brazilian pepper wetland patch is located along the disturbed western edge of the site.

Human-induced impacts to the functional attributes of the swale wetlands, including wetland hydrology and floral structure and composition, are minimal to none. Most impacts have been to isolated wetland systems that are replenished from rainfall, localized surface runoff, and the fluctuating water table. The western swale marsh is artificially connected to the Banana River Lagoon via the drainage ditch located along the southern boundary of the site. The cone of drainage influence from this ditch appears to be very minimal. This single ditch connection provides the regulatory nexus for the USACE to exert Section 404 CWA jurisdiction within this “connected” wetland system (Appendix H).

Curtiss reedgrass (*Calamovilfa curtissii*) densely covers most of the shallow marsh swales on the Alternative 2 site that exhibit short periods of permanent water. These marsh communities comprise about 14 ha (34 ac) on the Alternative 2 (Phases A-E) site. Due to its rarity, both globally and locally, Curtiss reedgrass was formerly listed as a candidate for Federal protection under the ESA and is currently designated as a threatened plant species by the State of Florida. KSC supports the largest populations in public ownership and nearly the only confirmed populations on the east coast of Florida (Johnson and Blyth 1988, Johnson 1993, Schmalzer et al. 2002b); other known populations are in the Florida panhandle. Thus, proper management of areas containing this grass is important to its survival.

Pine pinweed (*Lechea divaracata*), also formerly listed as a Federal candidate species, is now listed as endangered by the state of Florida (Coile 2000). It is found along the scrub ridges on the Alternative 2 (Phases A-E) site.

3.6.4.3 Phase F

Wetland resources on the Phase F site are limited to a isolated 0.5 ha (1.1 ac) Mixed Wetland Hardwoods (FLUCCS-6170) (Figure 3-16). The functional attributes of this remnant isolated wetland community have been degraded by the long-term operations of the adjoining citrus groves. Brazilian pepper has colonized heavily along the edges and is rapidly encroaching into the core of the wetland. Soil subsidence from the agricultural drainage systems was observed within this wetland.

3.6.5 Aquatic Resources

Aquatic resources for purposes of this document are defined as permanently flooded systems. Aquatic resources on the subject alternative sites are limited to artificial open water bodies and drainage ditches constructed primarily to support citrus cultivation or to route stormwater flows to nearby estuarine waters. These permanently flooded aquatic features are similarly defined as Surface Waters, as discussed above in Section 3.5.1 Surface Water and Floodplain.

3.6.5.1 Alternative 1

Artificial open water features on Alternative 1 (Phases A-E) are Reservoirs < 4 ha (10 ac) (FLUCCS-5340) and upland-cut Ditches (FLUCCS-5100) encompassing 1.9 ha (4.8 ac) and 3.0 ha (7.3 ac), respectively (Figure 3-16). The open water reservoirs consist of four distinct ponds that appear to have been dredged to provide consistent irrigation sources for nearby citrus cultivation. Deep, open water areas with a narrow littoral zone of primarily cattail (*Typha* spp.) characterize the reservoirs. The multiple, drainage ditches constructed throughout the site and the canal along Ransom Road are periodically sprayed and cleaned of debris and vegetation. Cattail is the primary plant species found growing within the limits of these aquatic resources. The ditches average 1.2 m (4 ft) wide and 1.5 m (5 ft) deep with steep side slopes. The canal along Ransom Road is a primary drainage conveyance feature averaging 3 m (10 ft) wide and 2 m (6 ft) deep.

3.6.5.2 Alternative 2

Aquatic resources identified on Alternative 2 (Phases A-E) site are limited to a shallow Reservoir < 4 ha (10 ac) (FLUCCS-5340) area located along the northern boundary that is densely colonized by cattail (*Typha* spp.) and an upland-cut Ditch (FLUCCS-5100) along the southern boundary (Figure 3-17). Similar to the drainage ditch design found at the Alternative 1 site, the ditch averages 1.2 m (4 ft) wide and 1.5 m (5 ft) deep with steep side slopes.

3.6.5.3 Phase F

Aquatic resources, as defined herein, are not present on the Phase F parcel.

A summary of the total area occupied by each community type classified on the Alternative 1 (Phases A-E), Alternative 2 (Phases A-E), and Phase F using FLUCCS is provided in Table 3-11.

Table 3-11. Area of Existing Land Use Types on ISRP Alternative Sites

FLUCCS Classification Code	Classification Description	Area (ha)	Area (ac)
Alternative 1 (Phases A-E)			
2211	Citrus Grove	99.7	246.4
5100	Upland Ditch	2.9	7.1
5340	Reservoirs < 4 ha (10 ac)	1.9	4.8
6170	Mixed Wetland Hardwoods	1.2	2.9
6190	Exotic Wetlands	4.6	11.4
6300	Wetland Forest Mixed	16.9	41.8
6410	Freshwater Marsh	0.6	1.5
TOTALS		**127.8**	**315.9**
Phase F			
2211	Citrus Grove	7.6	18.8
4140	Pine-Mesic Oak	1.8	4.5
6170	Mixed Wetland Hardwoods	0.5	1.1
TOTALS		**9.9**	**24.4**
Alternative 2 (Phases A-E)			
4111	Scrubby Pine Flatwood	74.6	184.4
4210	Oak Scrub	21.4	52.9
5100	Upland Ditch	0.5	1.1
5340	Reservoir < 4 ha (10 ac)	1.7	4.1
6170	Mixed Wetland Hardwoods	4.0	10.0
6190	Exotic Wetlands	0.2	0.4
6410	Freshwater Marsh	22.9	56.5
7400	Disturbed Scrubby Flatwoods	3.4	8.3
8145	Unpaved and Drained Roads	1.4	3.6
TOTALS		**130.1**	**321.3**

3.6.6 Endangered and Threatened Species

Currently, 19 Federal and State laws address conservation and protection of flora and fauna in Florida (NASA 1997a, 2002). The primary objectives of these laws are to establish the listing and delisting process for endangered and threatened species, to maintain data on current populations of species, to identify and protect critical habitat, and to protect those species that have been identified as threatened or endangered with extinction.

Plant and animal species designated as endangered or threatened by the USFWS and NMFS are listed in 50 CFR 17.11 and 17.12. The Florida Fish and Wildlife Conservation Commission (FFWCC) maintain the State of Florida list of protected species. The FFWCC lists animals as endangered, threatened, or species of special concern, (Rules 39-27.003, 39-27.004 and 39-27.005 FAC) The State lists plants as endangered, threatened or commercially exploited. State lists are administered and maintained by the Florida Department of Agriculture and Consumer Services (Chapter 5B-40, FAC)

3.6.6.1 Fauna

Of the 27 State and federally protected wildlife species known to regularly use the lands and waters of KSC (NASA 1997a, 2002), 11 are federally listed as threatened or endangered. Table 3-11 lists these species and also identifies those species potentially affected by the proposed ISRP development action for each alternative site. Accounts of the protected species, including brief discussions of their range, habitat and ecology, basis for classification and the status of the species at KSC, if known, may be found in NASA (1997a) and in Breininger *et al.* (1994). Although the American alligator is federally listed due to Similarity of Appearance to a Threatened taxon (SAT), it was delisted throughout its entire range on June 4, 1987 (52 FR 21059-21064). The USFWS reclassified the species to SAT primarily to minimize enforcement problems regarding other crocodilians that are threatened (52 FR 21059-21064). The final delisting of the American alligator is formal recognition that the species is biologically secure throughout its range. Delisting results in a long period of monitoring and USFWS can, if necessary, issue an emergency listing (to re-list)of a species. Federal agencies have a generalized responsibility under Section 7(a)(1), even if Section 7(a)(2) responsibility for consulting is concluded. The American alligator is listed by the State of Florida as a Species of Special Concern (SSC). Only individuals with proper licenses and permits can legally take alligators in Florida. Therefore, potential effects of the proposed ISRP action to the American alligator are considered herein due to its protection by the State of Florida.

Scrub and pine flatwoods and salt marsh required for the survival of the largest number of priority species on KSC, including federally and State-listed animal species (Breininger *et al.* 1994). Freshwater marshes, estuarine waters, open water impoundments, and salt marshes are habitat types used by the largest number of priority species. Priority species were defined as species that have been identified as vulnerable to significant population reductions or threats due to current situations regarding their ecology or biology. The broad-leaved forests on KSC are used by the fewest priority species (Breininger *et al.* 1994). Ditches, ruderal, and miscellaneous disturbed habitats are used by a large number of priority taxa; however, these artificial and altered areas are only required by a few species (Breininger *et al.* 1994).

Because gopher tortoises are a keystone species, the protection of this species is crucial for the whole ecosystem in which it lives. The gopher tortoise has a vital community role and is known as a keystone species because of the wide use of their burrows by numerous vertebrates and invertebrates (Eisenburg 1983, Breininger *et al.* 1994). State-listed commensal species that potentially use gopher tortoise burrows found on KSC include the Florida gopher frog, Florida pine snake (*Pituophis melanoleucus mugitus)*, and Florida mouse (*Podomys floridanus)*.

3.6.6.1.1 Alternative 1 (Phases A-E)

The Alternative 1 (Phases A-E) site, although largely altered by historic citrus cultivation, has the potential to be used by a total of nine protected wildlife species (Table 3-12). Of these species, two are federally protected, the eastern indigo snake (*Drymarchon corais couperi)* and wood stork (*Mycteria americana)*. The remaining seven include; the American alligator (*Alligator mississippiensis)*, the Southeastern American kestrel (*Falco sparverius paulus)*, and five wading birds species, all of which are protected by the State (Table 3-12). Each of the federally listed species is also protected by the State of Florida. Of these, the use of Alternative 1 by the American alligator and eastern indigo snake has been confirmed.

Table 3-12. State and Federally Listed Species Occurring at KSC and Potentially Occurring within Habitats on ISRP Alternative Sites

SCIENTIFIC NAME	COMMON NAME	LEVEL OF PROTECTION		ALT-1	PHASE F	ALT-2
Amphibians and Reptiles		STATE	FEDERAL			
Alligator mississippiensis	American alligator	SSC	SAT	X		X
Caretta caretta	Atlantic loggerhead turtle	T	T			
Chelonia mydas	Atlantic green turtle	E	E			
Dermochelys coriacea	Leatherback turtle	E	E			
Drymarchon corais couperi	Eastern indigo snake	T	T	X	X	X
Gopherus polyphemus	Gopher tortoise	SSC				X
Nerodia fasciata taeniata	Atlantic salt marsh snake	T	T			
Rana capito aesopus	Florida gopher frog	SSC				X
Pituophis melanoleucus mugitus	Florida pine snake	SSC				X
Birds						
Ajaia ajaja	Roseate spoonbill	SSC				X
Aphelocoma coerulescens	Florida scrub-jay	T	T			X
Charadrius melodus	Piping plover	T	T			
Egretta caerulea	Little blue heron	SSC		X		X
Egretta rufescens	Reddish egret	SSC		X		X
Egretta thula	Snowy egret	SSC		X		X
Egretta tricolor	Tricolored heron	SSC		X		X
Eudocimus albus	White ibis	SSC		X		X
Falco peregrinus tundrius	Arctic peregrine falcon	E				
Falco sparverius paulus	Southeastern American kestrel	T		X	X	X
Haliaeetus leucocephalus	Bald eagle	T	T			X
Mycteria americana	Wood stork	E	E	X		X
Pelecanus occidentalis carolinensis	Eastern brown pelican[a]	SSC				
Sterna antillarum	Least tern	T				
Rynchops niger	Black skimmer	SSC				
Mammals						
Peromyscus polionotus niveiventris	Southeastern beach mouse	T	T			
Podomys floridanus	Florida mouse	SSC				X
Trichechus manatus	West Indian manatee	E	E			
	TOTALS	**27**	**11**	**2 F/9 ST**	**1 F/2 ST**	**4 F/16ST**

Source: Logan 1997, USFWS 2003, Breininger *et al.* 1994, NASA 1997*a*, 2002
[a] The Brown Pelican is endangered by Federal Status in the U.S., except in Florida and Alabama where it was delisted due to recovery (50FR49384945 dated 02/04/85); ALT = Alternative; State (ST) = Florida Fish and Wildlife Conservation Commission; Federal (F) = United States Fish and Wildlife Service; E = Endangered; T = Threatened; SAT = Similarity of Appearance to Threatened Taxon; SSC = Species of Special Concern

The ditch and canal habitat type (FLUCCS-5100) and open water reservoirs (FLUCCS-5340) identified on the Alternative 1 (Phases A-E) site provide suitable habitat for use by American alligators. Ditches and canals on KSC are heavily used by alligators (Breininger *et al.* 1994). They feed and rest in the water and dig dens to lay eggs in the banks where young alligators spend their first several weeks (Breininger *et al.* 1994). The American alligator also commonly uses vegetated edges of impounded open water bodies, such as the reservoir habitat on Alternative 1, for feeding (Breininger *et al.* 1994). The American alligator was documented on the Alternative 1 site in May 2002 (JEA unpublished data 2002).

Wood storks also commonly use and require the shallow water vegetation interface along the edges of ditches, canals, and open water impoundments for feeding (Breininger *et al.* 1994). Numerous wading birds, although no Federal or State-listed species, were observed using the ditches within the orange groves and particularly the canal along Ransom Road (JEA unpublished data 2002). Although not documented, wood storks and State-listed wading birds likely periodically feed within the ditch and canal habitat type on Alternative 1. Roadside ditches are readily used for feeding by wading birds, including those listed as species of special concern by the State of Florida (Smith and Breininger 1995). Table 3-12 indicates the State-listed wading birds that may use the ditches occurring on the Alternative 1 site. Ditches are rarely used by the roseate spoonbill, a State-listed species of special concern (Breininger *et al.* 1994).

A large, approximately 2.1 m (7 ft), adult eastern indigo snake was documented in the southern part of the Alternative 1 site in January 2002 (JEA unpublished data 2002). The approximate location of this sighting was along the interface of a forested wetland hammock rimmed by a ditch and citrus grove habitat types as shown on Figure 3-16. The eastern indigo snake is the longest snake in the U.S., reaching lengths greater than 2.5 m (8 ft). They are federally listed as a threatened species, but protection and conservation are difficult. A four-year radio-telemetry study of eastern indigo snakes was conducted at KSC during the time period 1998 through 2002 (R. Smith, unpublished data). This study provided information on habitat utilization and extent of home ranges. Of 59 eastern indigos radio-tracked, 41 snakes were documented using hammock habitat. Thirteen of those snakes regularly used the hammock (between 10 and 41 separate tracking events, dependant on the length of time tracked). The researchers documented many observations of eastern indigos feeding in hammocks, and using tree stumps, sphagnum bogs, and ditches within hammocks as den sites (R. Smith unpublished data). The forested wetland hammocks on Alternative 1, particularly those located along the western project site boundary provide excellent feeding habitat and potential den sites (R. Smith pers. comm.).

Of 59 eastern indigos radio-tracked, 42 snakes were documented using disturbed habitats, including citrus groves. Twenty of those snakes regularly used disturbed habitats (between 10 and 55 separate tracking events, dependant on the length of time tracked). These sites were not always orange groves, but all had the common characteristic of a highly disturbed ground cover or shrub layer. Exotic or nuisance vegetation was often abundant. Numerous woody debris piles formed from dead citrus trees were observed within the citrus groves on Alternative 1. These debris piles potentially provide excellent shelter and den sites for eastern indigo snakes (R. Smith pers. comm., Speake *et al.* 1978, Moler 1986, Kehl *et al.* 1991).

Data from several radio-tagged eastern indigo snakes at KSC suggest that they frequently travel along and feed within the shallow-sloped ditches and surrounding vegetation (Kehl *et al.* unpublished data, R. Smith, unpublished data). Of 59 eastern indigos tracked, 22 (37 percent) were documented using ditches for feeding or den sites (37 percent) (R. Smith unpublished data). Three of those were documented using culverts to cross under roads (R. Smith unpublished data).

The average home range estimates, derived from a radio-telemetry study of 10 adult eastern indigo snakes, were 279.4 ha (690 ac) for males and 99.8 ha (247 ac) for females (Kehl *et al.* unpublished data). Although the majority of the natural community types historically occurring on the Alternative 1 site have been altered, this site is part of a large contiguous landscape presently characterized by few features that fragment the habitat, such as roads. Road mortality and intentional killing by humans were determined to be the two major sources of mortality of Eastern indigo snakes (R. Smith unpublished data). Development resulting in the fragmentation of habitat is the greatest threat to Eastern indigo snake populations for a number of reasons: snakes are forced to cross more roads in their daily travels, they are more likely to be seen and possibly killed by people, and the fire-maintained habitats that they use are degraded due to lack of fire (R. Smith unpublished data).

The southeastern American kestrel, a smaller version of the American kestrel (*Falco sparverius sparverius*), breeds throughout most of Florida (Smallwood and Collopy 1981). Feeding on mainly insects and small vertebrates, the southeastern kestrel prefers open habitats with scattered trees, as well as urban areas and cultivated habitats, such as citrus groves. Southeastern kestrels are considered rare visitors to KSC (Breininger *et al.* 1994). Few or no southeastern kestrels nest on KSC; although, a few individuals have been seen during the spring and summer when nesting kestrels should be present. Reasons for their general absence are not clear but may be attributed to the lack of suitable nest sites (as a result of past logging operations) and subsequent low potential for population recovery. An additional factor that may account for the rarity of this species on KSC may be linked to long-term fire suppression within the pine flatwoods on KSC. Fire suppression has reduced the amount of open pinelands habitat that is preferred by kestrels for foraging (Breininger *et al.* 1994).

Gopher tortoises, a State-listed SSC, are known to commonly use abandoned citrus groves. However, field surveys by JEA scientists in May 2002 and by Dynamac Corporation scientists in March 2003 determined that the citrus grove habitat type on Alternative 1 and the Phase F are not used by this species. Very poorly drained soils occur throughout most of the site and the area was historically covered by mesic hammocks. This habitat type is generally not considered potential gopher tortoise habitat due to high ground water table conditions and limited presence of herbaceous forage.

3.6.6.1.2 Phase F

Similar to the Alternative 1 site, the Phase F parcel is primarily composed of disturbed habitat types. As indicated on Table 3-12, the Phase F parcel has the potential for periodic use by two protected wildlife species, the eastern indigo snake and the southeastern kestrel. Neither of these species has been documented on the site.

It is expected that the Phase F is part of the home range of at least one Eastern indigo snake, based on the EA conducted for the SERPL facility (NASA 2000a). The sighting of an Eastern indigo on the Alternative 1 (Phases A-E) site and the suitable habitat on Phase F also support the finding of use by Eastern indigo snakes.

The potential use of the Phase F by the southeastern kestrel is expected to be very low due both in part to its rarity on KSC and the overgrown condition of the cultivated habitat on this site.

The Pine-Mesic Oak (FLUUCS-4140) habitat type is generally considered potential gopher tortoise habitat. Surveys conducted within this habitat type by JEA scientists in May 2002 determined the absence of gopher tortoise use within this area. This mesic upland community type is also underlain by very poorly drained soils.

3.6.6.1.3 Alternative 2 (Phases A-E)

The proposed Alternative 2 (Phases A-E) site is located within a large contiguous landscape exhibiting relatively high natural habitat heterogeneity with most habitats in optimal condition for use by dependent wildlife. As a result of the availability of high quality habitat, a total of 16 protected wildlife species are expected to use this site (Table 3-12). The site provides potential habitat for four federally protected species, including the Eastern indigo snake, Florida Scrub-jay, bald eagle (*Haliaeetus leucocephalus)*, and wood stork. Of these species, which are also protected under the State of Florida's wildlife laws, only the Florida Scrub-jay has been documented on the site. As indicated on Table 3-12, the remaining 12 species protected under the State of Florida wildlife laws include the American alligator, gopher tortoise and associated burrow commensals, wading birds, and the Southeastern American kestrel.

Florida Scrub-jay habitat occurs as a mosaic of oak scrub patches (focal habitat), embedded within a low and open mesic (moist) shrub landscape (matrix habitats) (Breininger *et al.* 1996, 2001). Optimal habitat quality features consider percentage of oak cover (>50 percent), percentage of open space (numerous open sandy areas among oaks), percentage of tree canopy cover (<15 percent), and the occurrence of shrub height (120 to 170 cm (3.9 to 5.6 ft)) without patches of tall scrub 170 cm (5.6 ft) comprising areas larger than 0.4 ha (1 ac). Breininger and Oddy (2001) recommend the use of structural habitat features, particularly scrub height, for identifying habitat suitability. Application of these Scrub-jay habitat suitability criteria determined that the entire Alternative 2 (Phases A-E) site is considered potential habitat for the federally threatened Florida Scrub-jay. A wildfire that swept across the Alternative 2 site in 1998 and subsequent harvesting of damaged pine trees resulted in optimal habitat conditions for Florida Scrub-jays throughout this site.

The Alternative 2 site is part of long-term demographic studies of a Scrub-jay population center inhabiting the predominant mesic pine flatwood landscape located east of Kennedy Parkway South (SR 3) and B Ave SW (Tel-4 Road). Within the study area, inclusive of Alternate 2, oak scrub occurs on the ridges, and marshes are located in troughs and pine flatwoods dominate the intermediate areas (Breininger and Oddy 2001). The 2002 scrub-jay territory maps for the Alternative 2 show that the site contributes wholly or partially to 10 scrub-jay territories (D. Breininger unpublished data). Based on this data, the 2002 Scrub-jay territories occupy the entire Alternate 2 (Phases A-E) site with the exception of approximately 4 ha (10 ac) of disturbed flatwoods habitat located in the extreme northwest corner of the site. Based on recent field observations of Scrub-jay use in 2003 of the subject disturbed scrubby flatwoods habitat area, all potential habitat on Alternative 2 is occupied.

The scrub and pine flatwoods habitat at KSC supports more endangered or potentially endangered species that are permanent residents then any other habitat (Breininger *et al.* 1994) at KSC. The Alternative 2 scrub (FLUCCS-4210) and pine flatwoods (FLUCCS-4110) habitat structure and composition is also optimal for use by the eastern indigo snake. The scrub and pine flatwoods habitat type is considered critical for the continuation of this species on KSC (Breininger *et al.* 1994). Eastern indigo snakes use all habitats within the pine flatwoods landscape, feeding on amphibians within marshes and using the numerous gopher tortoise burrows that occur on the scrub ridges and in the intermediate mesic areas as den sites (Breininger *et al.* 1994). Although eastern indigo snakes have not been documented within the proposed Alternative 2 project boundaries, radio-telemetry studies conducted during 1998-2002 tracked them using similar nearby flatwoods habitat areas located just south of the Alternative 2 site (R. Smith unpublished data). It is expected that Alternative 2 is occupied by at least one eastern indigo, and likely contributes to several eastern indigo snake home ranges (R. Smith pers. comm.).

Pine flatwoods, with large mature pines, are the primary nesting habitat type for bald eagles at KSC and are considered critical to the continuation of this species on KSC (Breininger *et al.* 1994). Bald eagle nesting is not documented within the Alternative 2 site boundaries, however two active bald eagle nest are within 1 km (0.625 mi) of the southeast boundary of the site (FWC 2002). The closest nest is 650 m (2112.5 ft) from the southeast corner of Alternative 2. An additional active eagle nest is within 2 km (1.25 mi) of the northeast boundary of the site (FWC 2002). Figure 3-18 provides the approximate location of the nearest eagle nests to the ISRP alternative sites.

In addition to the federally protected species listed above the open scrub and flatwoods habitat on Alternative 2 (Phases A-E) provides potential habitat to the southeastern kestrel and gopher tortoise, both State-listed threatened species. Preliminary field surveys conducted by Dynamac biologists found that gopher tortoise densities at Alternative 2 (Phases A-E) are high, ranging from 1.7 to 2.8 tortoises/ha (0.7 to 1.1 tortoises/ac) within the scrub and pine flatwoods habitat. Multiplying the number of active burrows identified within the estimated area of the survey transects by a correction factor of 0.28 derived this estimate. This correction factor was developed at KSC using a camera system to survey burrows (Breininger *et al.* 1988, 1991). The FWC uses a correction factor of 0.614, therefore, use of the correction factor developed for similar habitat at KSC provides for a more conservative estimate of population density. Breininger *et al.* (1988) reported an average density of 1.3 tortoises/ha in KSC scrub and pine flatwoods habitat. The observed high densities on the Alternative 2 site may be attributed to the optimal habitat conditions resulting from the 1998 fire. Areas of open, low herbaceous cover are abundant. State-listed commensal species that potentially use the Alternative 2 site due to the high occurrence of gopher tortoise burrows and suitable habitat conditions are the Florida gopher frog, Florida pine snake, and Florida mouse.

The Reservoir <4 ha (10 ac) (FLUCCS-5340) located along the northern boundary of Alternative 2 (Phases A-E) and the ditch along the southern boundary provide potential habitat to both the American alligator and wood stork (R. Smith pers. comm.).

The freshwater wetland swale marshes (FLUCCS-6410) have important roles in community structure within the scrub and mesic pine flatwoods landscape (Breininger *et al.* 1994). The swale marshes on Alternate 2 (Phases A-E) provide suitable feeding habitat for numerous State and federally listed species at KSC, including the eastern indigo snake, American alligator, gopher tortoise, bald eagle, roseate spoonbill, little blue heron, snowy egret, tricolored heron and white ibis (Breininger *et al.* 1994, Stolen *et al.* 2002). Wood storks rarely use freshwater swale marshes at KSC (Breininger 1992, Stolen *et al.* 2002), preferring the numerous ditches and canals and open-water impoundments (Breininger *et al.* 1994). No wood storks were seen during field surveys of Alternative 2 (Phases A-E).

The ephemeral marshes on Alternative 2 (Phases A-E) provide critical breeding habitat to several amphibian species, including the State-listed Florida gopher frog, which spends its adult life primarily in the nearby upland habitat (Moler and Franz 1987). Gopher frogs are not commonly observed at KSC, having only been detected north of the Haulover Canal in 1992 and along B Ave SW (Tel-4 Road) in 1994 (Breininger et al 1994).

Road)

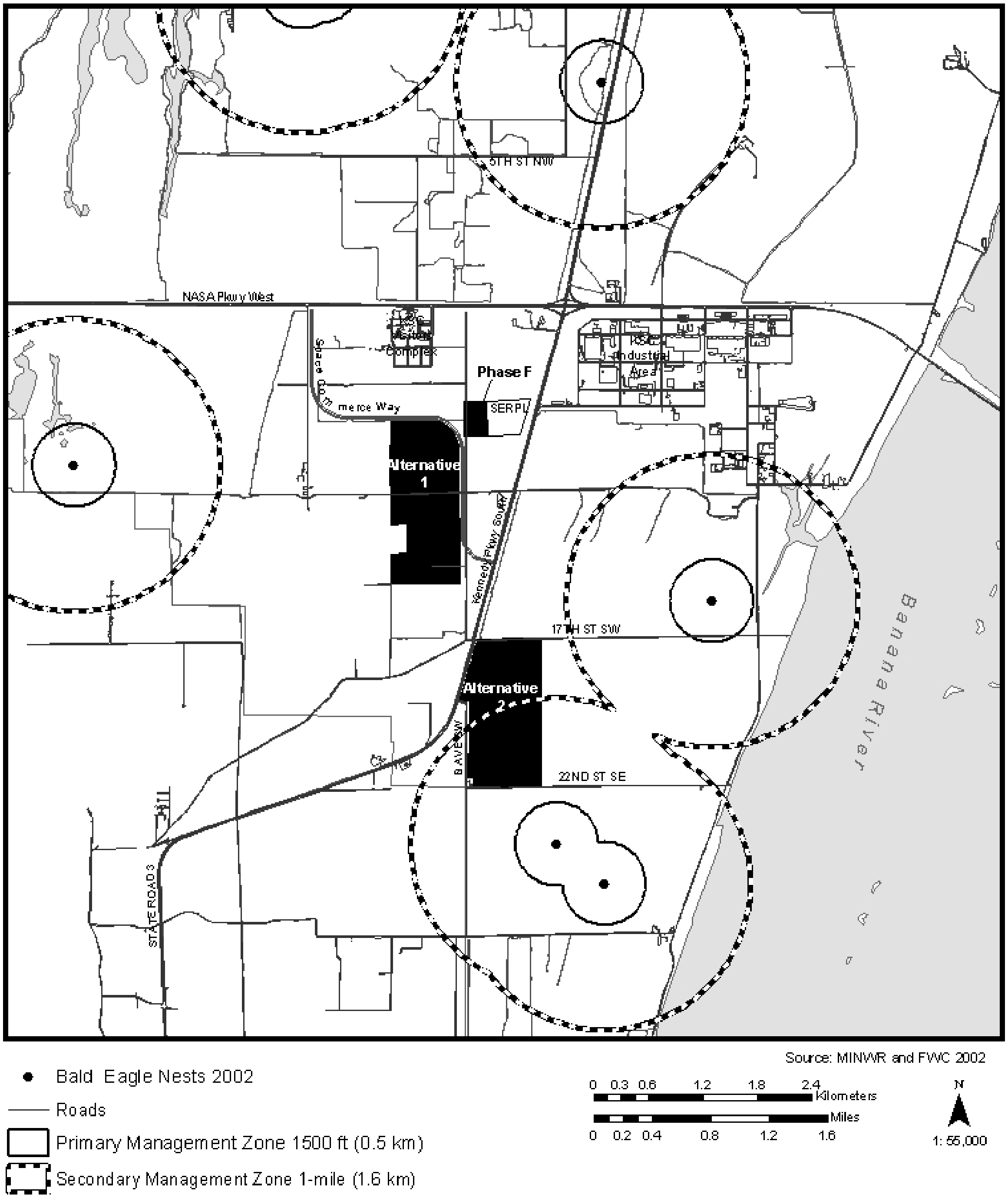

Figure 3-18. Bald Eagle Nest Locations for 2002 Nearest to the Proposed ISRP Alternatives.

The B Ave SW (Tel-4) sighting is in the vicinity of the proposed Alternative 2 site. The reason for the rarity of this species on KSC is uncertain since suitable habitat occurs throughout KSC (Breininger *et al.* 1994). The vulnerability of this species to local population decline and extinction is high due to its patchy distribution, low dispersal potential, and dependence on ephemeral marshes for reproduction (Breininger *et al.* 1994).

3.6.6.2 Flora

The vascular floras at KSC were first studied in the 1970's (Sweet 1976, Poppleton *et al.* 1977), and the list was revised in 1990 (Schmalzer and Hinkle 1990a). Nomenclatural and taxonomic changes, as well as, additional collections required a new revision of this list. This update was completed in June 2002, in *Revised Flora and List of Threatened and Endangered Plants for the John F. Kennedy Space Center Area, Florida* (Schmalzer *et al.* 2002b). The information presented below was taken directly from this updated study and applied to the proposed ISRP action. The revised list includes 1024 taxa of which 803 are native and 221 are introduced. This appears to be a substantial proportion of the regional flora taxa. Fifty taxa are endemic or nearly endemic to Florida, a level of endemism that appears high for the east coast of Florida. Of the 221 introduced plants, 26 are Category I invasive exotics and 15 are Category II invasive exotics. Category I species are invasive exotics that are altering native plant communities by displacing native species, changing community structures or ecological functions, or hybridizing with natives. Category II species have increased in abundance or frequency but have not yet altered Florida plant communities to the extent shown by Category I species.

Thirty-eight taxa are listed as threatened, endangered, or of special concern on State lists. No federally listed plant species occur at KSC; however, nine plant species were formerly candidates for Federal listing (Schmalzer *et al.* 2002b). These species include Curtiss reedgrass (*Calamovilfa curtissii*),found in the shallow wetland swales, and pine pinweed (*Lechea divaracata*) found along the scrub ridges on the Alternative 2 (Phases A-E) site.

Table 3-13 provides a list of the endangered and threatened plants of the KSC area (Schmalzer *et al.* 2002b). For some of these taxa, populations on KSC appear to be important for their regional and global survival. The bryophyte flora of the KSC area includes 23 mosses and 20 liverworts and hornworts (Whittier and Miller 1976). The lichen flora is currently unknown (Schmalzer *et al*. 2002b).

Endangered and threatened plants occur in various habitats on KSC including coastal dunes, coastal strand, scrub, pine flatwoods, hammocks, hardwood swamps, marshes, and mangrove swamps. The hammocks and hardwood swamps have a high concentration of threatened and endangered plants, even though these communities make up a relatively small proportion of the total vegetation of KSC (Provancha *et al*. 1986). Whittier and Miller (1976) noted the importance of hammocks to the bryophyte flora.

3.6.6.2.1 Alternative 1 (Phases A-E)

The 16.9 ha (41.8 ac) of Wetland Forest Mixed (FLUUCS-6300) provide potential suitable habitat for a total of 16 plants listed as endangered, threatened, special concern, or commercially exploited based on the association of these plants with hammock and hardwood swamp habitats of KSC (Schmalzer *et al*. 2002b). The likelihood for occurrence of protected plant species within the Mixed Wetland Hardwoods (FLUCCS-6170) embedded within the citrus groves is significantly reduced due to adverse changes within this wetland habitat resulting from abiotic edge effects, such as changes in microclimate (Harris 1984, Saunders *et al*. 1991),and infestation by exotic plants.

The Exotic Wetlands (FLUCCS-6190) and maintained fallow Citrus Grove (FLUCCS-2211) are not recognized as common habitats of protected plants documented to occur on KSC (Schmalzer *et al*. 2002b).

Table 3-14, modified from Schmalzer *et al.* (2002b), indicates those endangered and threatened plants potentially associated with wetland hammock habitat occurring on the Alternative 1 site.

3.6.6.2.2 Alternative 2

As indicated on Table 3-13, the high quality upland and wetland habitats classified on Alternative 2 have the potential to support 19 plants listed as endangered, threatened, special concern, or commercially exploited (Schmalzer *et al*. 2002b). The scrub and pine flatwoods (FLUCCS-4110 and FLUCCS-4210) communities provide potential suitable habitat for a total of seven protected plants (Schmalzer *et al*. 2002b) (Table 2). Pine pinweed (*Lechea divaricata*), a former Federal candidate species is listed as endangered by the State of Florida, is present in scrub openings at Alternative 2 (P. Schmalzer pers. comm.). A 1998 wildfire that burned across the entire Alternative 2 site significantly improved the suitability of the scrub habitat on Alternative 2 for recruitment of pine pinweed by enhancing the occurrence of sandy openings preferred by this plant. Three protected plants known to occur on KSC are associated with freshwater marsh (FLUCCS-6410) habitats (Schmalzer *et al*. 2002b), such as the swale marshes (FLUCCS-6410) classified on Alternative 2. Curtiss reedgrass (*Calamovilfa curtissii)*, a former Federal candidate species is listed as threatened by the State, is abundant within the shallower swale marshes on Alternative 2 that exhibit short periods of water inundation. The Mixed Wetland Hardwood (FLUCCS-6170) habitats classified on Alternative 2 (Phases A-E) are hardwood swamps and that potentially provide habitat to nine listed plant species commonly associated with this habitat type, including plants that are epiphytic in hammocks (Schmalzer *et al.* 2002b).

3.6.6.2.3 Phase F

Disturbances to the upland and wetland hammocks (FLUCCS-4140 and FLUCCS-6170) on the Phase F site are similar to that described above for the embedded wetlands on the Alternative 1 site, where the potential for occurrence of the species of concern was low. Therefore, the potential for occurrence of the 16 protected plants commonly associated with hammocks and hardwood swamps as indicated on Table 3-14 is considered low.

Table 3-13. Status of Endangered and Threatened Plants of the Kennedy Space Center Area (Schmalzer *et al.* 2002b)

		Designated Status[1]			
Scientific Name	**Common Name**	**USFWS[2]**	**FDA[3]**	**FCREPA[4]**	**FNAI[5]**
Amyris balsamifera	Balsam torchwood				G4, S2
Asclepias curtissii[6, 8, 9]	Curtiss milkweed		E		G3, S3
Avicennia germinans[6, 7, 8]	Black mangrove			SP	
Calamovilfa curtissii[6, 7]	Curtiss reedgrass	FC2	T		G1G2,S1S2
Calopogon multiflorus	Many-flowered grass pink		E		
Chamaesyce cumulicola[9]	Sand dune spurge	FC2	E		G2,S2
Chrysophyllum oliviforme[6, 7, 9]	Satinleaf		T		
Encyclia tampensis	Butterfly orchid		C		
Epidendrum canopseum	Greenfly orchid		C		
Harrisella filiformis	Threadroot orchid		T		
Hexalectris spicata	Crested coralroot		E		
Lantana depressa var. *floridana*[7, 9]	East coast lantana	FC2	E		G2T2, S2
Lechea cernua[6, 9]	Nodding pinweed	FC2	T		G3, S3
Lechea divaricata[7]	Pine pinweed	FC2	E		G2, S2
Lilium catesbaei	Catesby lily		T		G4, S3
Myrcianthes fragrans[7]	Nakedwood	FC2	T		G4T3, S3
Ophioglossum palmatum[6, 8, 9] *(= Cheiroglossa palmate)*	Hand fern		E	E	G5, S2
Opuntia stricta[7]	Shell mound prickly-pear		T		
Osmunda cinnamomea[7]	Cinnamon fern		C		
Osmunda regalis var. *spectabilis*[7]	Royal fern		C		
Pavonia spinifex[9]	Yellow hibiscus				G4G5, S2S3

Table 3-13. (continued)

Scientific Name	Common Name	USFWS	FDA	FCREPA	FNAI
Peclumula plumula *(=Polypodium plumula)*	Plume polypody		E		
Peperomia humilis	Peperomia		E		G5, S2
Peperomia obtusifolia[8]	Florida peperomia		E		G5, S2
Persea borbonia var. *humilis*[6, 7]	Scrub bay				G3, S3
Pogonia ophioglossoides	Rose pogonia		T		
Pteroglossaspis ecristata (= *Eulophia ecristata*)	False coco		T		G2G3, S2
Remirea maritima[7, 9,10] (=*Cyperus pedunculatus*)	Beach-star		E		
Rhizophora mangle[6, 7,8]	Red mangrove			SP	
Scaevola plumieri[7, 10]	Scaevola		T		
Sophora tomentosa	Necklace pod				G4, S3
Spiranthes laciniata	Lace-lip ladies'-tresses		T		
Tephrosia angustissima var. curtissii	Narrow-leaved hoary pea; coastal hoary pea	FC2	E		G1T1, S1
Tillandsia utriculata	Giant wild pine; giant air plant		E		
Tournefortia gnaphalodes[8] *(= Argusia gnaphalodes)*	Sea lavender		E	T	G4, S3
Verbena maritima[6, 7, 9] *(= Glandularia maritima)*	Coastal vervain	FC2	E		G2, S2
Verbena tampensis[6, 7] *(= Glandularia tampensis)*	Tampa vervain	FC1	E		G1, S1
Zamia umbrosa[6, 8] (= *Zamia pumila*)	East coast coontie		C	T	

Table 3-13 (continued)

		USFWS	**FDA**	**FCREPA**	**FNAI**
	TOTALS	FC1-1	E-16	E-1	20
		FC2-8	T-11	T-2	
		9	C-5	SP-2	
			32	5	
	GRAND TOTAL-38				

[1] E = Endangered; T = Threatened; SP = Special Concern; C = Commercially Exploited
[2] United States Fish and Wildlife Service. FC1 and FC2 indicate species that were formerly under consideration for listing.
[3] Florida Department of Agriculture and Consumer Services (Coile 2000).
[4] Florida Committee on Rare and Endangered Plants and Animals (Ward 1978).
[5] Florida Natural Areas Inventory (Marois 1997). FNAI assigns two ranks for each element. The global element rank is based on an element's worldwide status; the state element rank is based on the status of the element in Florida. Element ranks are based on factors including estimated number of element occurrences, estimated abundance, range, estimated adequately protected element occurrences, relative threat of destruction, and ecological fragility.
Global Element Rank:
G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or less than 1000 individuals) or because of extreme vulnerability to extinction due to some natural or man-made factor.
G2 = Imperiled globally because of rarity (6 to 20 occurrences or less than 3000 individuals) or because of vulnerability to extinction due to some biological or man-made factor.
G3 = Very rare and local throughout its range (21-100 occurrences or less than 10,000 individuals), or found locally in a restricted range, or vulnerable to extinction because of other factors.
G4 = Apparently secure globally (may be rare in parts of range)
G5 = Demonstrably secure globally
G#T# = Rank of taxonomic subgroup such as subspecies or variety; numbers have same definition as above
State Element Rank:
Definitions parallel global element ranks: substitute "S" for "G" in global ranks, and "in state" for "globally" in global rank definitions.
[6] Sites or populations identified by Poppleton (1981)
[7] Sites or populations known from Kennedy Space Center Ecological Program work (1982-2002)
[8] Listed in Final Environmental Impact Statement for Kennedy Space Center (NASA 1979)
[9] Cape Canaveral Air Force Station sites or populations identified by Chafin *et al.* (1996)
[10] Cape Canaveral Air Force Station sites or populations identified by Schmalzer and Oddy (1995)

Table 3-14. Common Habitats of Endangered and Threatened Plants of the Kennedy Space Center Area Indicating Potential for Occurrence on ISRP Alternative Sites (modified from Schmalzer *et al.* 2002b)

Scientific Name	**Common Name**	**Habitat**[4]	**Potential For Occurrence on ISRP Alternative Sites**		
			Alternate 1	Phase F	Alternative 2
Amyris balsamifera	Balsam torchwood	Coastal hammock			
Asclepias curtissii[1, 3]	Curtiss milkweed	Oak scrub			X
Avicennia germinans	Black mangrove	Mangrove swamps			
Calamovilfa curtissii[1, 2]	Curtiss reedgrass	Shallow swales in pine flatwoods			X
Calopogon multiflorus	Many-flowered grass pink	Pine flatwoods			X
Chamaesyce cumulicola[3]	Sand dune spurge	Coastal dunes, strand and scrub			
Chrysophyllum oliviforme[1, 3]	Satinleaf	Hammocks	X	X	
Encyclia tampensis	Butterfly orchid	Hammocks, hardwood swamps – epiphytic	X	X	X
Epidendrum canopseum	Greenfly orchid	Hammocks, hardwood swamps – epiphytic	X	X	X
Harrisella filiformis	Threadroot orchid	Hardwood swamps – epiphytic	X	X	X
Hexalectris spicata	Crested coralroot	Hammocks	X	X	
Lantana depressa var. *floridana*[2, 3]	East coast lantana	Coastal strand and scrub			
Lechea cernua[1, 3]	Nodding pinweed	Scrub openings			X
Lechea divaricata[2]	Pine pinweed	Scrub openings			X
Lilium catesbaei	Catesby lily	Pine flatwoods			X
Myrcianthes fragrans[1]	Nakedwood	Hammocks, coastal strand	X	X	

Table 3-14. (continued)

Scientific Name	**Common Name**	**Habitat**[4]	**Potential For Occurrence on ISRP Alternative Sites**		
			Alternate 1	Phase F	Alternative 2
Ophioglossum palmatum[1, 3] *(= Cheiroglossa palmata)*	Hand fern	Hammocks - epiphytic on cabbage palm	X	X	X
Opuntia stricta[2]	Shell mound prickly-pear	Coastal dunes and strand			
Osmunda cinnamomea[2]	Cinnamon fern	Hardwood swamps	X	X	X
Osmunda regalis var. *spectabilis*[2]	Royal fern	Hardwood swamps	X	X	X
Pavonia spinifex[3]	Yellow hibiscus	Hammocks	X	X	
Peclumula plumula (=Polypodium plumula)	Plume polypody	Hammocks – epiphytic	X	X	X
Peperomia humilis	Peperomia	Hammocks	X	X	
Peperomia obtusifolia	Florida peperomia	Hammocks – epiphytic	X	X	X
Persea borbonia var. *humilis*[1, 2]	Scrub bay	Scrub			X
Pogonia ophioglossoides	Rose pogonia	Marshes and wet pine flatwoods			X
Pteroglossaspis ecristata (= *Eulophia ecristata*)	False coco	Scrub and dry flatwoods			X
Remirea maritima[2, 3] *(= Cyperus pedunculatus)*	Beach-star	Coastal dunes			
Rhizophora mangle[2]	Red mangrove	Mangrove swamps			
Scaevola plumieri[2]	Scaevola	Coastal dunes and strand			
Sophora tomentosa	Necklace pod	Coastal strand and hammocks			
Spiranthes laciniata	Lace-lip ladies'-tresses	Marshes			X

Table 3-14. (continued)

Scientific Name	**Common Name**	**Habitat**[4]	**Potential For Occurrence on ISRP Alternative Sites**		
			Alternate 1	Phase F	Alternative 2
Tephrosia angustissima var. curtissii	Narrow-leaved hoary pea; coastal hoary pea	Coastal dunes and strand			
Tillandsia utriculata	Giant wild pine; giant air plant	Hammocks and hardwood swamps – epiphytic	X	X	X
Tournefortia gnaphalodes (= Argusia gnaphalodes)	Sea lavender	Coastal dunes			
Verbena maritima[1, 2, 3] *(= Glandularia maritima)*	Coastal vervain	Coastal dunes and strand – openings			
Verbena tampensis[1, 2] *(= Glandularia tampensis)*	Tampa vervain	Edge of hammocks	X	X	
Zamia umbrosa[1] (= *Zamia pumila*)	East coast coontie	Hammocks	X	X	
TOTALS			**16**	**16**	**19**

[1] Sites or populations identified by Poppleton (1981)

[2] Sites or populations identified by Kennedy Space Center Ecological Program (1982-2002) (Schmalzer and Hinkle 1990, Schmalzer *et al.* 1999, Schmalzer unpublished)

[3] Sites or populations identified by Chafin *et al.* (1996)

[4]Hammock and Hardwood Swamp classification in Schmalzer *et al.* 2002b fit the following FLUCCS codes used to describe similar habitats on all ISRP Alternative Sites: 4140, 6170, and 6300.
Marshes and shallow swales (Schmalzer *et al.* 2002b) fit FLUCCS code 6410 classified on Alternative 2
Oak Scrub, Scrub, and Pine flatwoods (Schmalzer *et al.* 2002b) fit FLUCCS codes: 4111 and 4210

3.7 SOCIO-ECONOMICS

Factors that describe the socio-economic environment represent a composite of several interrelated and non-related factors. This section describes several indicators of socio-economic conditions around KSC, including information about population, income, employment, housing and indicators of social conditions at the county and state levels. This section also describes the region's existing economic conditions. Finally, this section concludes with a discussion of environmental justice, including low-income and minority population statistics around KSC.

3.7.1 Area of Socio-economic Interest

KSC is located in Central Florida west of geographic Cape Canaveral on Merritt Island. KSC encompasses all northeast beach areas of Brevard County and northern Merritt Island. Federal property extends north along coastal Brevard County to include the southern edge of Volusia County (Figure 13-19). The region of influence for the socio-economic analysis has been defined as Brevard County and the five adjoining counties (Indian River, Orange, Osceola, Seminole, and Volusia Counties). The six county region covers approximately 1.5 million ha (3.7 million acres or 5,780 square miles (mi^2). Nearly 17 percent of this area is urbanized or devoted to transportation and other rights of way. About 22 percent of the land in the region is agricultural. KSC occupies about 56,500 ha (139,490 ac) of Merritt Island. Only about 3 percent (1,806 ha; 4,463 ac) of KSC is used for NASA operations. About 40 percent of KSC (22,582 ha; 55,800 ac) is open water. CCAFS occupies about 6,394 ha (15,800 ac) of the barrier island. The City of Cape Canaveral is located to the south of CCAFS.

3.7.2 Population Characteristics

Population distribution and growth rates are two basic measurements of socio-economic conditions. The United States experienced a 38 percent increase in population between 1970 and 2000; however, this increase was not evenly distributed. More than 50 percent of this growth occurred in just three states: California, Florida, and Texas. According to data compiled by the University of Florida, Bureau of Economic and Business Research (BEBR), Florida's population increased 134 percent between 1970 and 2000. The population in Brevard County has increased every year with an overall growth of 108 percent. The growth rate of Brevard County is slightly lower than the State average. Most of Brevard County's population resides along the Indian River and the Atlantic Ocean. In 2000, the most populous incorporated areas were Palm Bay (79,413 persons), followed by Melbourne (71,382), Titusville (40,670), Rockledge (20,170), Cocoa (16,412), and Cocoa Beach (12,482). The unincorporated area of Merritt Island, sparsely populated in 1960, had a population of 36,090 in 2000 During the 1980s, Port St. John, between Titusville and Cocoa, and Micco, south of Melbourne, developed rapidly. The U.S. Census Bureau has designated Brevard County as the Melbourne-Titusville-Palm Bay Metropolitan Statistical Area,

Of the five counties bordering Brevard County, Osceola County experienced the greatest increase in growth over 30 years (564 percent), followed by Seminole County (332 percent) and Indian River County (213 percent). Florida's average population density 1.14 people per ha (296.4 people permi^2) are substantially higher than the United States average of 0.31 people per ha (79.6 people per mi^2). Population density of Brevard County is substantially higher at 1.81 people per ha (468 people permi^2). Significant increases or decreases in population can be an indicator of significant environmental impacts from a project. Population numbers are reflected in Table 3-15.

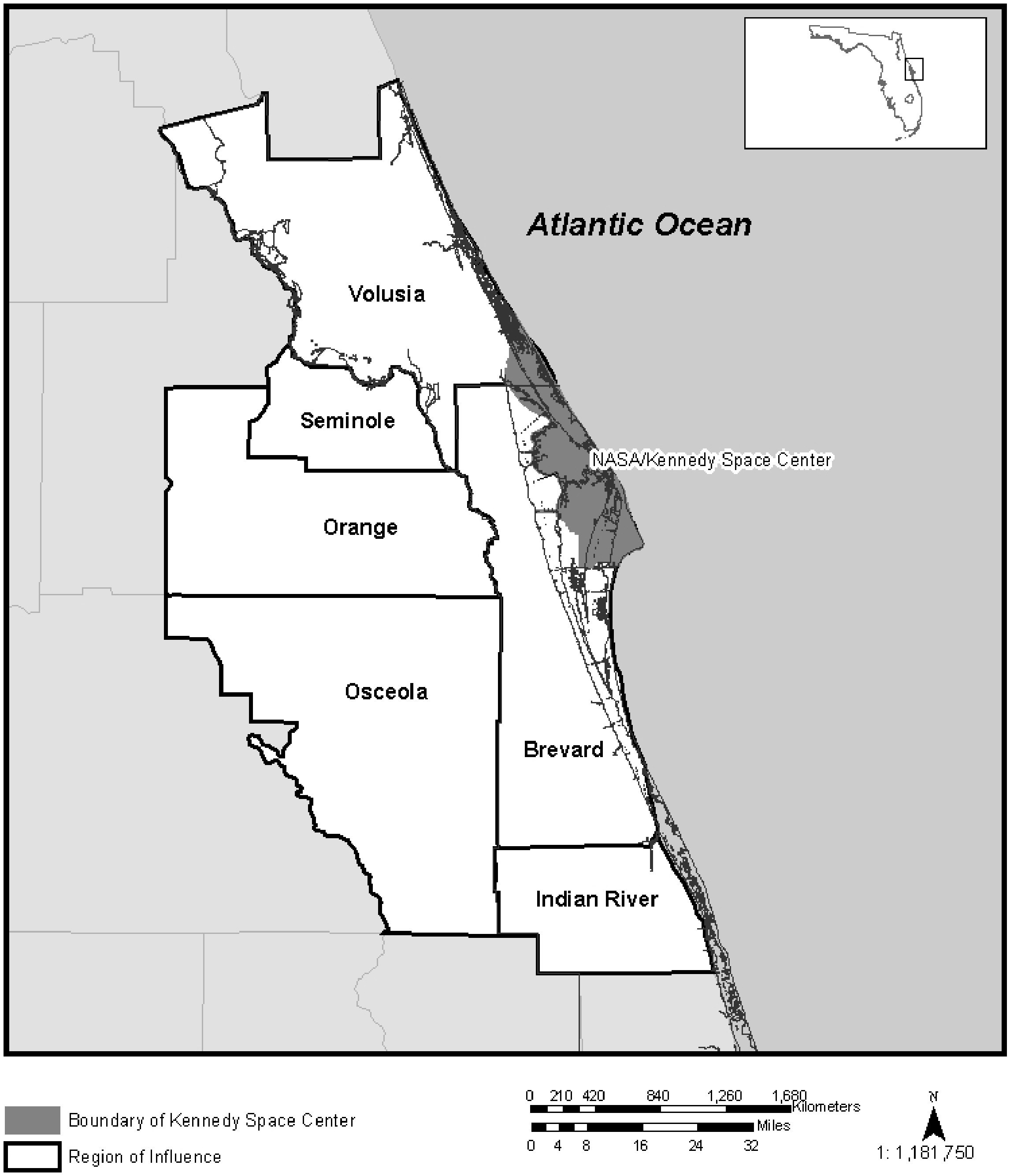

Figure 3-19. Region of Influence for Socio-Economic Analysis of Alternatives for the International Space Research Park.

Table 3-15. Historic Population

Year	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
1970	230,340	36,307	348,410	25,941	85,309	171,060	6,865,915
1980	275,664	60,728	474,742	50,634	181,968	261,444	9,839,895
1990	401,681	90,862	683,337	110,253	290,616	372,945	13,018,127
2000	478,467	113,639	904,767	172,253	368,387	445,520	16,069,434
Overall Growth (30 years)	108%	213%	160%	564%	332%	160%	134%
Population Density (in 2000)	467.7	224.4	987.8	130.5	1,184.9	401.9	296.4

Source: Bureau of Economic and Business Research (2002); U.S. Census Bureau (2000).

Projections through 2015 indicate that the average annual growth in county population is expected to increase at a rate of approximately 537,000 persons per 10-years. The population growth is estimated to increase at a slower rate than in the past. The projected population of the State of Florida is expected to increase by 27 percent in 2015. Highest population growth rates are expected in Osceola County (48 percent), followed by Orange County (39 percent) and Seminole County (31 percent). Brevard, Indian River, and Volusia Counties are projected to grow by 25-27 percent over the 2000 population. Orange County is expected to remain the most populated county around the KSC (Table 3-16, Figure 3-20).

Table 3-16. Projected Population Growth

Year	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
2005	519,100	126,400	1,029,500	202,600	413,700	483,300	17,616,400
2010	562,300	136,300	1,147,100	232,100	452,700	525,400	19,075,600
2015	599,400	144,000	1,258,800	255,400	480,700	560,100	20,388,600
Projected Growth (since 2000)	25.3%	26.8%	39.1%	48.2%	30.5%	25.7%	26.9%

Source: Bureau of Economic and Business Research (2002).

3.7.3 Age Distribution

The median age for the State of Florida is 38.7 years. The populations of Seminole, Osceola, and Orange Counties are slightly younger than the State average, with median ages of 36.2, 34.6, and 33.3 years, respectively. Brevard, Volusia, and Indian River Counties have populations slightly older than that of the state, with median ages of 41.4, 42.4, and 47.0 years, respectively. Persons over the age of 65 represent 17.6 percent of Florida's population. In Brevard, Volusia, and Indian River Counties, 19.9, 22.1, and 29.2 percent of the population is over the age of 65, respectively. In Orange, Seminole, and Osceola Counties, 10.0, 10.6, and 11.4 percent of the population is over the age of 65, respectively (Table 3-17).

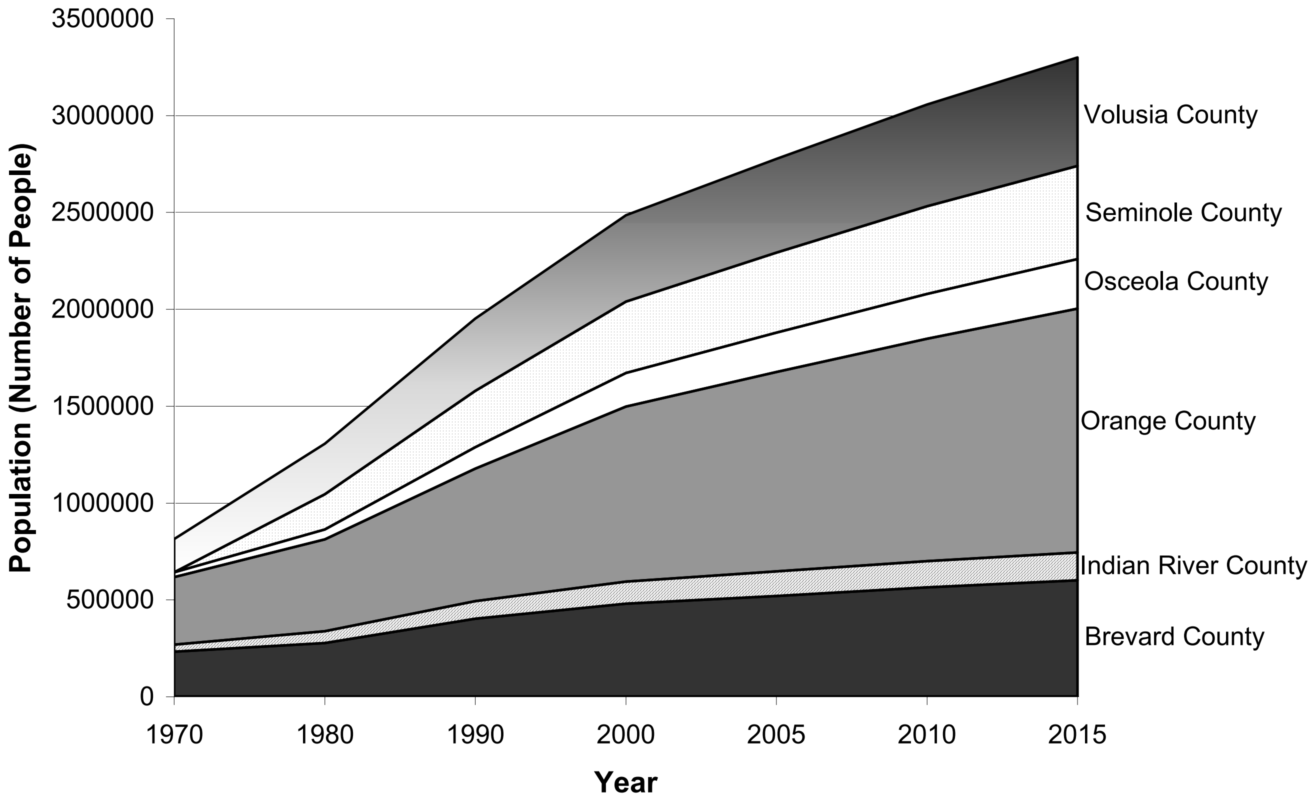

Figure 3-20. Historic and Projected Population.

Table 3-17. Age Distribution (Year 2000)

Year	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
Persons under 18 years old	27.2%	23.9%	32.1%	33.6%	31.7%	25.2%	28.7%
Persons 19 to 64 years old	52.9%	46.9%	57.9%	55%	57.7%	52.7%	53.7%
Persons over 65 years old	19.9%	29.2%	10.0%	11.4%	10.6%	22.1%	17.6%
Median Age (years)	41.4	47.0	33.3	34.6	36.2	42.4	38.7

Source: U.S. Census Bureau (2000)

3.7.4 Per Capita Personal Income

Personal income provides an important indication of the economic condition of an area. The historic per capita income for the State of Florida, from 1970 to 2000, increased by 89 percent to $25,915. Orange County's income grew 85.1 percent. Indian River and Seminole Counties experienced the highest per capita income growth at 139.1 and 149.0 percent, respectively. Indian River County has the highest per capita income in 2000. Per capita income in Brevard County was about $2,000 less than the state average. The figures in Table 3-18 represent the ratio of total personal income, from all sources and before income taxes, to total resident population.

Table 3-18. Historic Per Capita Income

Year	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
1970	$13,429	$13,891	$13,416	$12,786	$11,719	$12,391	$13,744
1980	$17,223	$20,168	$16,604	$15,327	$16,899	$15,553	$17,617
1990	$21,538	$29,788	$21,879	$17,425	$22,433	$19,276	$22,951
2000	$23,942	$33,220	$24,833	$17,451	$29,178	$21,068	$25,915
Overall Growth (30 years)	78.3%	139.1%	85.1%	36.5%	149.0%	70.0%	88.6%

Source: Bureau of Economic and Business Research (2002).

Per capita income for Florida is projected to increase 38 percent compared to 2000. Seminole, Osceola, and Indian River Counties are projected to increase at a higher rate than the State average, with Indian River County continuing to have the highest per capita income (Table 3-19, Figure 3-21). Brevard County is projected to increase less than the surrounding counties and the State average, and have a per capita income about $4,000 less than the State average.

Table 3-19. Projected Per Capita Income

Year	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
2005	$25,788	$36,760	$26,936	$19,193	$32,144	$22,638	$28,412
2010	$28,171	$41,066	$30,245	$21,522	$36,349	$24,855	$31,551
2015	$31,441	$46,769	$33,863	$24,702	$41,669	$28,035	$35,689
Projected Growth (since 2000)	31.3%	40.8%	36.4%	41.6%	42.8%	33.1%	37.7%

Source: Bureau of Economic and Business Research (2002).

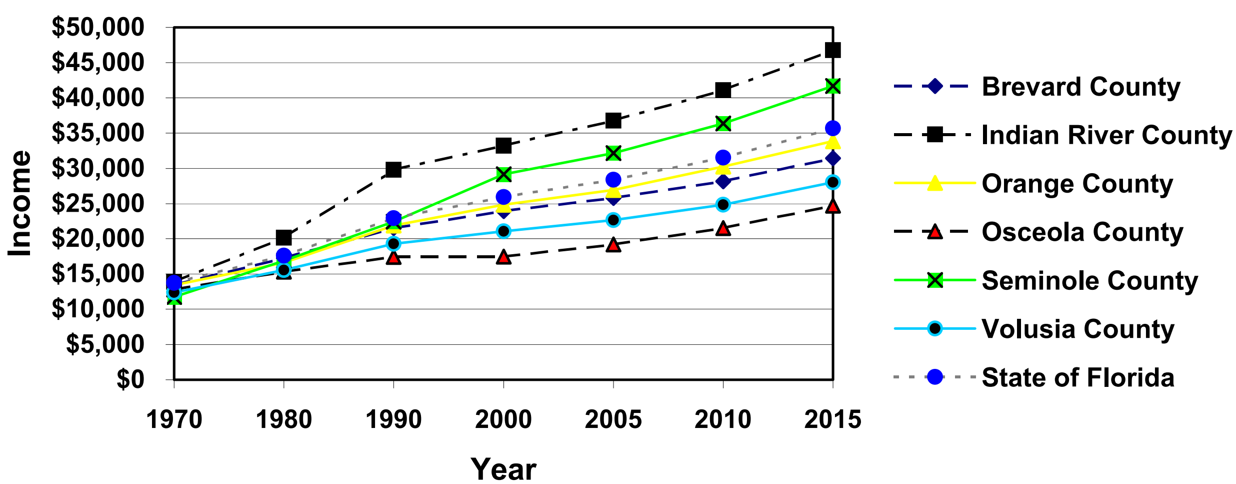

Figure 3-21. Historic and Projected Per Capita Income.

3.7.5 Employment

The level of employment for a geographic area can provide insight into the economic condition of that area. As with income, employment data can provide an indication of economic trends. Data pertaining to the total number of people employed, employment by aggregated industry segment, and unemployment rates are provided in Table 3-20, Table 3-21 and Table 3-22. For Brevard County, 43 percent of the County's labor force resides within the County. Of the surrounding counties, Seminole County has the largest labor force as a percent of county population (58.1 percent) and Volusia County the lowest (38.8 percent) (Enterprise Florida). Employment types and industries in the six counties generally follow the trend for the State of Florida, with a few exceptions. In 2000, agriculture, forestry, and fishing comprised only 1.3 percent of the State of Florida's employers and industries. However, the percent of employers and industries for agriculture, forestry, and fishing in Indian River County was nearly 2.5 times that of the State. Brevard, Orange, Osceola, and Seminole Counties had fewer employers and industries in agriculture, forestry, and fishing (0.5, 0.5, 0.6, and 0.3 percent, respectively) than the State. Volusia County had a similar rate (1.1 percent) as Florida.

Construction, manufacturing, and transportation comprised 20.6 percent of the employers and industries of Florida in 2000. Similar rates occurred in Indian River, Orange, Osceola, and Volusia Counties (18.4, 19.4, 20.1, and 21.9 percent, respectively). The employer and industry rates for construction, manufacturing, and transportation for Seminole and Brevard Counties were noticeably less (16 percent) and greater (25.6 percent) than the rate for Florida, respectively. Professional, scientific, and management represented 10.6 percent of the employers and industries in Florida in 2000. Brevard, Indian River, Orange, and Volusia Counties had rates similar to that of Florida, ranging from 9.2 to 11.5 percent. The employer and industry rates for professional, scientific, and management for Osceola and Seminole Counties were noticeably less (6.9 percent) and greater (13.2 percent) than the rate for Florida, respectively.

Table 3-20. Employment by Type and Industry (2000)

Industry	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
Agriculture, Forestry, Fishing	0.5%	3.2%	0.5%	0.6%	0.3%	1.1%	1.3%
Construction, Manufacturing, and Transportation	25.6%	18.4%	19.4%	20.1%	16%	21.9%	20.6%
Retail and Wholesale trade	15.9%	18.4%	16%	16.5%	18%	16.9%	17.5%
Professional, Scientific and Management	10.5%	9.6%	11.5%	6.9%	13.2%	9.2%	10.6%
Education, Health, and Social Services	17.4%	19.2%	14.4%	12.3%	17.3%	19.6%	18.1%
Other Services	30.1%	31.2%	38.1%	43.7%	35.2%	31.3%	31.9%

Source: U.S. Census Bureau (2000)

The historic employment levels for the State of Florida and the counties around KSC all experienced increases in employment levels from 1970 to 2000 (Table 3-21). Employment growth for the State of Florida from 1970 to 2000 was 31.4 percent. The historic employment growth rates for Brevard, Indian River, and Volusia Counties were less than that of Florida for the same thirty-year period (15.8, 27.7, 18.2 percent, respectively).

Table 3-21. Historic Employment Level

Year	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
1970	75,800	9,269	122,997	4,797	15,663	44,100	2,152,100
1980	102,200	18,059	228,474	14,194	45,460	77,700	3,576,200
1990	165,365	31,422	435,387	37,408	93,401	124,315	5,387,338
2000	191,492	40,124	642,566	54,216	147,172	146,955	7,080,567
Overall Growth (30 Years)	15.8%	27.7%	47.6%	44.9%	57.6%	18.2%	31.4%

Source: Bureau of Economic and Business Research (2002).

Employment levels for Florida and by county have steadily increased over the past 30 years (Table 3-22). The number of employed persons is projected to continue to increase through 2015. The number of persons employed in Florida is projected to increase 30 percent by 2015, compared to 2000. Orange, Osceola, and Seminole Counties are projected to experience the greatest increases in employment, 42 percent, 50 percent, and 49 percent, respectively), and also a rate higher than the State average (Figure 3-22). These increases are also in line with data previously presented which projected Orange, Osceola, and Seminole Counties to experience population growth greater than the State average. Similarly, Brevard and Volusia Counties are projected to experience lower increases in employment levels compared to the state average. Table 3-21 shows that the historic growth rates in overall State employment will continue, but the growth will be at a lower rate. Conversely, the growth in the number of employed people in Brevard County increases significantly.

Table 3-22. Projected Employed Persons

Year	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
2005	202,100	45,700	728,300	63,300	173,400	160,600	7,868,400
2010	217,100	49,800	832,700	73,600	200,400	176,600	8,653,200
2015	230,000	51,900	910,800	81,200	219,700	186,300	9,223,900
Projected Growth (since 2000)	20.1%	29.4%	41.7%	49.8%	49.3%	26.8%	30.3%

Source: Bureau of Economic and Business Research (2002).

As the number of people employed has increased overall, unemployment rates have generally decreased during the same period, despite the overall increase in population. The 2000 unemployment rate for the State of Florida was 3.6 percent. Brevard County had a similar unemployment rate of 3.4 percent. Orange, Osceola, Seminole, and Volusia Counties had unemployment rates lower than that of the State of Florida. However, Indian River County had an unemployment rate (6.4 percent) 1.5 times greater than that of the State of Florida, and as much as 2.5 times greater than the other counties listed, as can be seen in Table 3-23.

The unemployment rate for the six Counties and the State has been projected by the BEBR to increase. It is assumed that this increase in unemployment rates is due to the economic recession that the United States has experienced beginning in the late 1990s. Between 2000 and 2015, the unemployment rate of the State of Florida is projected to increase 25 percent.

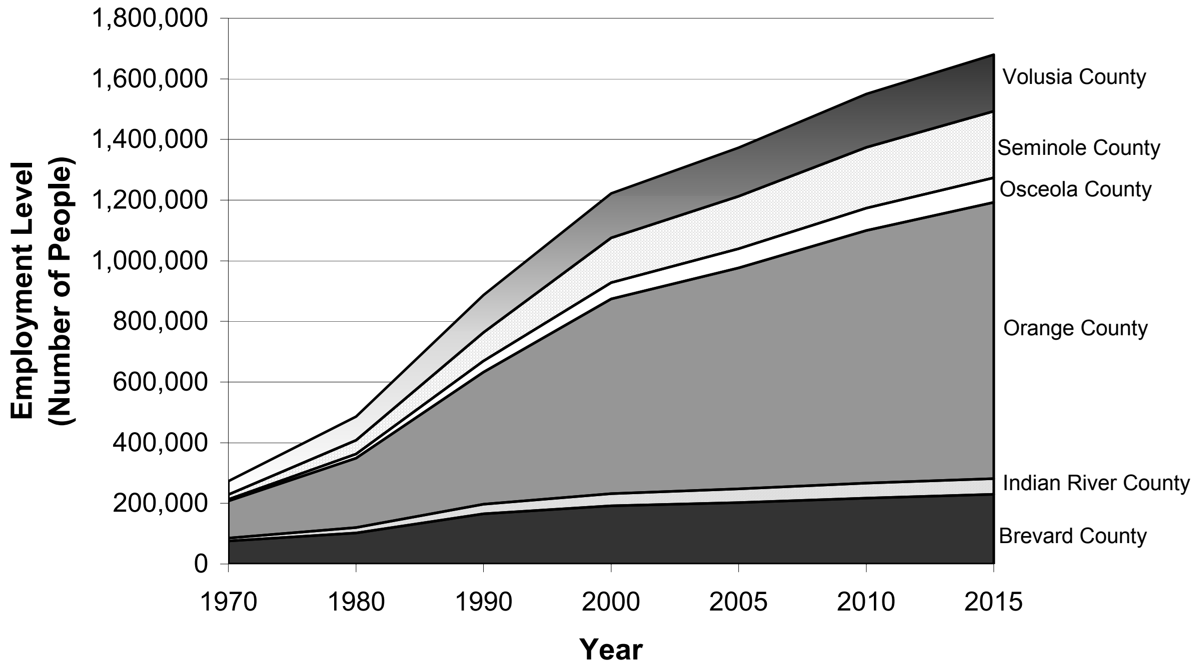

Figure 3-22. Historic and Projected Employment Level.

Table 3-23. Current (2000) and Projected Unemployment Rate

Year	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
2000	3.4%	6.4%	2.5%	2.8%	2.5%	2.8%	3.6%
2005	4.9%	8.6%	4.2%	4.7%	3.9%	4.2%	5.0%
2010	4.3%	7.4%	3.6%	4.2%	3.4%	3.6%	4.3%
2015	4.5%	7.6%	3.6%	4.3%	3.6%	3.7%	4.5%

Source: Bureau of Economic and Business Research (2002).

The State of Florida and Brevard County are projected to have equal unemployment rates (4.5 percent). Orange, Seminole, and Volusia Counties are projected to have lower unemployment rates than the State average in 2015, similar to the unemployment condition of 2000. Indian River County is projected to continue to have the highest unemployment rate, more than 1.5 times the State average in 2015 (Figure 3-23).

3.7.6 KSC Workforce (Historical and Current)

KSC is Brevard County's largest single employer and a major source of revenue for local firms. KSC operations create a chain of economic effects throughout the region. Each job created within Brevard County's space industry is estimated to generate an additional 1.93 jobs within the region (NASA 1997b). Other large employers in the County are Patrick Air Force Base, the Brevard County School District, and Health First. Approximately 15,200 personnel are employed at KSC in 2003, a number that includes contractor, construction, tenant, and permanent civil service employees. On KSC, civil service employees account for approximately 12 percent of the total workforce.

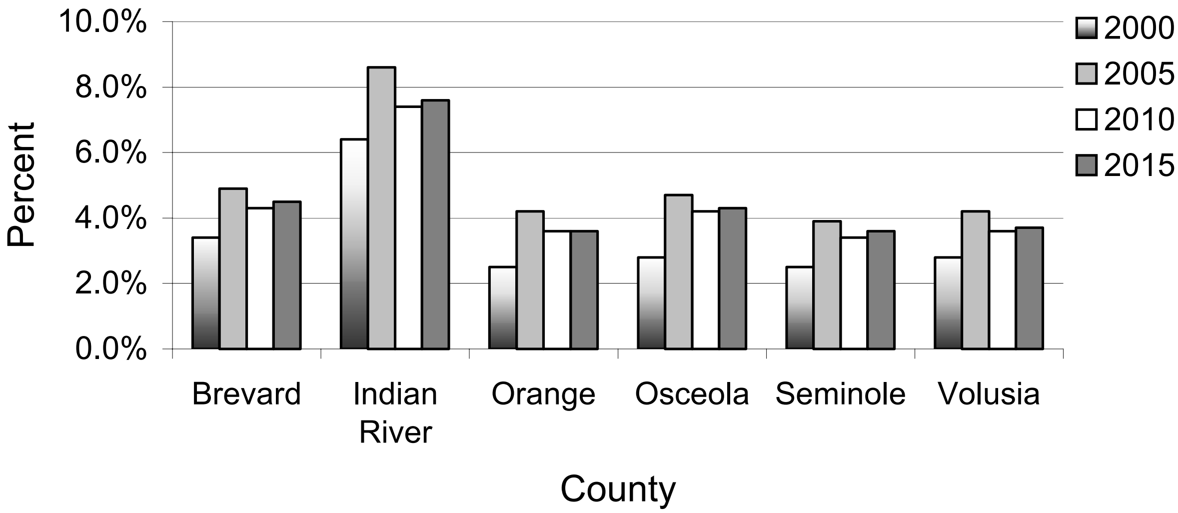

Figure 3-23. Current and Projected Unemployment Rate.

The highest employment levels at KSC were recorded during the Apollo program. In 1968, KSC recorded a peak population of 25,895, with an estimated one in four workers in Brevard County employed by operations at KSC. Employment levels dropped precipitously following the Apollo program to a historic low in 1976 when a total of 8,441 personnel were employed. Employment levels rose sharply in 1979 when KSC was designated as the launch and operations support center for the Space Shuttle Program.

Approximately 50 percent of the 15,200 personnel at KSC have positions directly related to the Shuttle and payload processing operations. The remaining workforce is employed in ground and base support, unmanned launch programs, crew training, engineering, and administrative positions. The largest concentration of personnel is stationed in the Launch Complex-39 Area, the next largest concentration is in the Industrial Area. Remaining personnel are stationed at various outlying facilities at KSC and at the CCAFS. A chart of KSC personnel levels since 1964 is provided in Figure 3-24.

3.7.7 Regional Economics

The aerospace industry represents $4.5 billion of Florida's annual economy, with more than one-half of that revenue generated by companies within the Space Coast. Twenty-six counties in Florida are home to more than 180 space-related businesses that employ more than 23,000 people. Since 1989, FSA has fostered nearly $650 million in new Florida space projects, including launch pads, processing facilities, control centers for space transportation, research laboratories, tourism facilities, and academic programs (Witt 2001). The Central Florida region is strong in several high-tech sectors, including aviation and aerospace, information technology, microelectronics, modeling, simulation, training, optics, and photonics (Futron 2002).

The major Space Coast destinations are the beaches, KSC's Visitor Complex, and Port Canaveral cruise ship terminals. In 1999, the total visitor market to Orlando was estimated at 43 million guests. The total number of visitors to the Space Coast was estimated at 3.8 million in 1999, with a total of more than 13 million visitor days (Economic Research Associates 2001). Tourism represents about 20 percent of Florida's total economy, generating approximately $50 billion in taxable sales in 2002 (Florida 2003). Approximately $5.6 to $6.9 billion of state tax collections in Florida in 1999 came from direct and indirect tourism-related activities. This tax collection is out of $21.9 billion statewide or 26 percent to 32 percent of the State's total sales tax collections (Baker 2001). The State sales tax, together with the other transactions taxes, account for 77 percent of the State's taxation (Wenner 2001). Tourists pay an estimated 48 percent of the total sales taxes collected in Orange County, and about $125.9 million of the total State sales tax revenues of $283 million returned to Orange County Public Schools in FY 2000 (Orlando 2003).

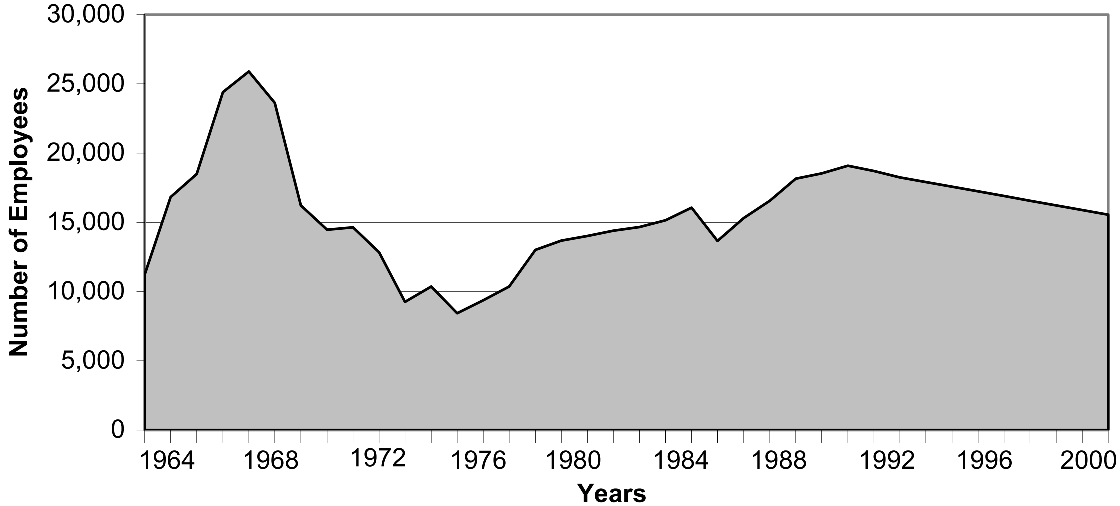

Figure 3-24. Kennedy Space Center Historical Workforce Levels.

Source: NASA (1997a) and NASA KSC Master Planning Office

Annually, Brevard County has about 18,580 square meters (m^2) (200,000 square feet (ft^2)) of unused office space, and 32,516 m^2 (350,000 ft^2) of unused industrial space, including manufacturing, research and development, and warehouse and distribution space. In 2001, northern Brevard County had 31,716 m^2 (341,384 ft^2) of office space, 72 percent of which was occupied, and 179,303 million m^2 (1.93 million ft^2) of industrial space, about 54 percent of which was vacant (Urban Land Institute 2001). NASA and FSA have proposed a "Class A" standard for the design and use of facilities in ISRP. Class A buildings are characterized by high quality, multi-story buildings, extensive use of glass, structure parking, proximity to amenities and transportation corridors, high quality finishes, and a building lobby featuring marble or granite floors and walls. The Business Case Analysis Development Study for the ISRP found no comparable "Class A" office space in the Titusville/Cocoa corridor. The study found the closest "Class A" space on the east side of Orlando, roughly 48 km (30 mi) away. Example lease rates (for 2002) at those facilities are:

Orlando	5,193 m^2 at $236.81/ m^2 (55,900 ft^2 at $22.00/$ft^2$)
Orlando	11,520 m^2 at $227.55/ m^2 (124,000 ft^2 at $21.14/$ft^2$)
Winter Park	3,293 m^2 at $226.04/ m^2 (35,450 ft^2 at $21.00/$ft^2$)
Maitland	10,500 m^2 at $212.59/ m^2 (113,019 ft^2 at $19.75/$ft^2$)
Orlando	5,574 m^2 at $204.51/ m^2 (60,000 ft^2 at $19.00/$ft^2$)

The Vector Space Park, located across the Intercoastal Waterway in Titusville, is the closest comparable industrial park in the area. However, lack of available or vacant office space prevented deriving a comparable lease rate comparison. Many, "Non-class A" facilities with smaller increments of square feet are available for lease along the east coast from Melbourne to Titusville. Monthly lease rates for these facilities, depending on use of occupancy (office versus open floor plan), range from \$75.00 per m^2 (\$7.00 per ft^2) to \$172.23 per m^2 (\$16.00 per ft^2).

Real taxable sales provide a way to analyze the number of dollars spent in an area. Such sales include visitor and tourist sales and provide insight to local dollars spent. Table 3-24 provides the current (2000) and projected real taxable sales for the State, Brevard County, and the surrounding counties. The following table demonstrates the projected real taxable sales. Care should be used when interpreting these numbers. The Florida Department of Revenue Taxable aggregates and derives data to identify sales; similarly, residents tend to spend a substantial proportion of their incomes in metropolitan areas due to better selections and prices. These factors reduce the reliability and precision of these data when analyzed by county.

Table 3-24. Current (2000) and Projected Real Taxable Sales (in millions of 1997 dollars)

Year	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
2000	$5,230	$1,535	$24,889	$2,556	$5,440	$5,125	$244,258
2005	$6,271	$1,918	$29,817	$3,318	$6,635	$6,645	$293,921
2010	$7,647	$2,496	$40,137	$4,421	$8,701	$8,481	$378,838
2015	$9,939	$3,267	$54,379	$5,888	$11,478	$11,115	$502,817
Projected Growth (since 2000)	90%	113%	118%	130%	111%	117%	106%

Source: Bureau of Economic and Business Research (2002).

3.7.8 Housing

Various housing indicators provide a good gauge of the economic development in an area. The number of households in the State of Florida in 2000 was 6,372,700. The six counties around KSC together represent approximately 15.3 percent of total households in Florida (Table 3-25). The percent of owner-occupied units in the State was 70.1 percent in 2000. Brevard, Volusia and Indian River Counties had 74.6 percent, 75.3 percent and 77.6 percent owner-occupied units, respectively. Vacant units represented 13.2 percent of all units in the State in 2000, including seasonal rentals, vacant, or available housing. Brevard County had 10.8 percent vacant units. The median housing value for the State of Florida in 2000 was \$105,500. The median housing cost for Seminole County (\$119,900) was highest of the counties studied, and correlates with the County's high per capita income. However lower median housing cost in Indian River County did not correlate with its high per capita income. Brevard, Osceola, and Volusia Counties had lower median housing costs (\$94,400, \$99,300,and \$87,300, respectively). The median housing rent for the State was \$641 in 2000. All six counties had median housing rent within \$100 of the state average. Enterprise Florida compiles a cost of living, price level index for all Florida counties. The cost of living indexes for Brevard County, and the five adjoining counties, were all below the Florida average in 2000.

Brevard County's real estate market has been growing, with an annual absorption of 3,800 housing units (Urban Land Institute 2001). Housing projections are derived from a forecast of the housing stock, taking into account the increasing number of households, changing vacancy rates, and the replacement of obsolescent housing. The number of Florida households is projected to increase by 33 percent between 2000 and 2015. Similar rates of increase are projected for Brevard, Indian River, Seminole, and Volusia Counties (33 to 35 percent). The number of households in Orange and Osceola Counties are projected to increase at 43 percent and 54 percent, respectively, a higher rate than the State average.

Table 3-25. Housing and Cost of Living

Number of Households	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
2000	199,100	49,400	339,500	61,600	140,800	185,600	6,372,700
2005	218,000	55,600	389,200	72,500	159,900	204,300	7,050,800
2010	240,700	61,200	438,100	84,700	177,000	227,100	7,762,200
2015	265,300	66,900	485,500	95,000	189,800	247,600	8,459,600
Projected Growth (since 2000)	33.2%	35.4%	43.0%	54.2%	34.8%	33.4%	32.7%
Percent owner-occupied units[1]	74.6%	77.6%	60.7%	67.7%	69.5%	75.3%	70.1%
Percent vacant units[1]	10.8%	15.1%	6.9%	15.7%	5.1%	12.8%	13.2%
Household size[1]	2.35	2.25	2.61	2.79	2.59	2.32	2.46
Median Housing Value[1]	$94,400	$104,000	$107,500	$99,300	$119,900	$87,300	$105,500
Median Housing Rent[1]	$604	$615	$699	$714	$731	$597	$641
Cost of Living Index, Housing (2001)[2]	91.93	90.34	95.56	93.22	91.42	90.08	100
Cost of Living Index, Total (2001)[2]	96.41	96.09	97.67	96.36	95.87	95.62	100

Source: Bureau of Economic and Business Research (2002); [1]U.S. Census Bureau (2000); [2] Enterprise Florida, County Profiles

3.7.9 Social Conditions

Mobility of a population can be an indicator of social conditions and social stresses. Residents of communities with high rates of population change may not feel satisfied or comfortable; fewer residents may volunteer and participate in community activities; and residents may place higher demand on community services. About 52 percent of residents in Brevard, Indian River, and Volusia Counties lived in the same house in 2000 that they did in 1995, a higher rate than the State average (48.9 percent). A much lower percentage of residents of Orange and Osceola Counties lived in the same house in 2000 and 1995 (42.3 percent and 40 percent, respectively). A relatively high percentage of Osceola and Seminole County residents lived in a different county in 1995 (29.4 percent and 29.9 percent, respectively), while residents of the other counties were closer to the State average of 21 percent. The number of residents living in a different state in 1995 was higher than the State average for all counties, with Osceola County being the highest at 17.6 percent. Of the six counties, Orange County had the greatest influx of residents from different states between 1995 and 2000, while Indian River had the smallest influx of residents from other states. Data on migration are provided in Table 3-26, below.

Fire protection at KSC includes a comprehensive program of fire protection engineering, fire prevention, fire suppression and emergency response operations. Three Fire Stations, two located in the Launch Complex-39 Area and one located in the Industrial Area provide effective coverage for all of KSC. Coordination support agreements between KSC and local municipalities provide for reciprocal support in the event of an emergency or disaster.

Table 3-26. Migration and Immigration, 5 Years Prior to Year 2000 Census
Percent in parenthesis

Residence in 1995	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
Same house	233,156 (51.6%)	56,122 (52.1%)	352,921 (42.3%)	64,477 (40.0%)	160,281 (46.9%)	218,008 (51.7%)	7,352,091 (48.9%)
Different house	218,397 (48.4%)	51,623 (47.9%)	482,366 (57.8%)	96,548 (60.0%)	181,668 (53.1%)	203,545 (48.3%)	7,691,512 (51.1%)
Different county	94,529 (20.9%)	27,408 (20.5%)	212,989 (25.5%)	47,406 (29.4%)	102,230 (29.9%)	96,125 (22.8%)	3,172,722 (21.1%)
Different state	65,665 (14.5%)	15,940 (14.8%)	115,640 (13.8%)	28,410 (17.6%)	47,113 (13.8%)	58,642 (13.9%)	1,860,772 (12.4%)

Source: U.S. Census Bureau (2000).

Medical first-care treatment services are available at KSC by an Occupational Health Facility and an Emergency Aid Clinic. Other medical facilities include the Jess Parish Medical Center, Health First Holmes, Palm Bay, and Cape Canaveral Hospitals, Wuesthoff Memorial Hospital, and Patrick Air Force Base.

Residents of Brevard County and the surrounding counties also have numerous opportunities and choices for medical services and shopping. Recreational opportunities in Brevard County include 169 parks, 21 nature trails, 26 golf courses, 18 tennis courts, 72 miles of beaches, five major museums/historical points of interest, and several cultural events and festivals (see Section 3.16 Recreation) (Enterprise Florida 2003).

3.7.10 Education Level

Education level can be a good indicator of social conditions and “quality of life” of residents. In the State of Florida, 79.9 percent of the population has graduated from high school or has attained some higher level of education. Brevard and Seminole Counties have the highest percentage of population that have graduated from high school or achieved a higher level of education (86.3 percent and 88.7 percent, respectively) (Table 3-27). Approximately 22.3 percent of Florida’s population has a bachelor’s or higher-level degree. The highest proportion of the population with a bachelor’s degree or higher resides in Seminole County (31.0 percent). In Indian River, Brevard, and Orange Counties, 23.1, 23.6, and 26.1 percent of the populations, respectively, have a bachelor’s degree or higher. The percent of populations in Osceola and Volusia Counties with a bachelor’s degree or higher (15.7 and 17.6 percent, respectively) is less than that for the State of Florida.

3.7.11 Crime Rates

Crime rates are another indicator of social conditions. The index rate per 100,000 people for the State of Florida, in 2001, was 5,579.9. Orange County exceeded the State of Florida’s index rate by 132 percent, and had the highest rate for all listed crimes when compared to the other five counties (Table 3-28). All crimes committed in Orange County represented 5.2 to 8.1 percent of the listed crimes committed in the State of Florida. More than 85% of the crimes committed in Orange County were rated as non-violent. The index rate of Brevard County was 89 percent of Florida’s index rate, and all crimes committed represented 3.7 percent of all crimes committed in the State. Seminole and Indian River Counties had index rates that were 74 and 65 percent, respectively, of Florida's index rate.

Table 3-27. Education Level

Education Level	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
No high school diploma	35,102	10,299	73,160	16,285	19,337	41,756	1,480,726
High school graduate	98,108	24,572	148,006	37,536	59,280	102,353	3,165,748
Associate degree	30,395	5,215	46,419	7,664	22,014	24,981	773,486
Bachelor's degree	51,616	12,833	104,818	12,052	51,235	36,646	1,573,121
Graduate or professional degree	28,404	6,700	45,191	5,364	24,256	19,315	889,207
Percent high school graduate or higher	86.3	81.6	81.8	79.1	88.7	82.0	79.9
Percent bachelor's degree of higher	23.6	23.1	26.1	15.7	31.0	17.6	22.3

Source: U.S. Census Bureau (2000), Census 2000.

Table 3-28. Index Crime Rates and Number of Offenses, 2001

Crime	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
Murder	15	3	45	4	7	20	867
Forcible sex offense	471	81	716	161	211	422	12,756
Robbery	659	57	2,618	233	352	611	32,808
Aggravated Assault	2,616	296	6,561	718	1,641	2,162	83,892
Burglary	4,263	950	12,795	2,825	2,721	4,862	175,671
Larceny	14,725	2,649	38,660	5,316	9,438	11,749	515,501
Motor vehicle theft	1,419	187	7,273	586	1,227	1,616	89,797
Index Rate per 100,000	4,981.3	3,649.5	7,383.4	5,482.5	4,126.6	4,744.1	5,579.9

Source: Florida Department of Law Enforcement (2001).

3.7.12 Public Schools

Public education is a basic public service, and availability and quality of the public educational system can be a good indicator of social conditions. Available public education indicators that can be related to social condition may include pupil to teacher ratios, school size, and per pupil expenditures. Brevard County and the surrounding five counties are all characterized by relatively large elementary schools where the average number of elementary students per school is more than 500 students (Table 3-29). Indian River has the lowest average school size (500 students), followed by Brevard (600), Volusia (610), Orange (725), Seminole (780), and Osceola County (975). Average elementary class size is also high for some counties, including Volusia (25.7) and Osceola (25.4). An average class size of 22 is a common benchmark. The more specialized subject areas at the middle- and high-school levels make conclusions on standard class size difficult. Per pupil expenditures by each school district is generally within 5 percent of the State average, with the exception of Seminole County, which is about 12 percent below the State average.

Colleges and universities serving Brevard County include Barry University, Brevard Community College, Florida Institute of Technology, University of Central Florida, Keiser College, Rollins College, and Webster University. Additional colleges and universities are available to residents of adjoining counties.

Table 3-29. Public Schools

Parameter	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
Average Class Size							
Elementary	21.7	23.1	21.2	25.4	22.2	25.7	24.1
Middle School	23.9	28.9	25.8	27.4	24.9	22.0	25.9
High School	24.6	24.9	27.2	25.6	26.4	23.0	26
Per (regular) pupil expenditures	$4,582	$4,372	$4,309	$4,155	$3,874	$4,005	$4,378

Source: Florida Department of Education (2002).

3.7.13 Environmental Justice

EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, directs Federal agencies to identify and address, as appropriate, the disproportionately high and adverse health or environmental effects of their programs, policies, and activities on minority populations and low-income populations. In December 1997, the CEQ issued guidance on environmental justice. KSC has developed an Environmental Justice Plan (NASA 1997b) to comply with the EO and NASA's agency-wide strategy by: 1) defining the terms "low-income populations," "minority," "minority populations," "disproportionately high adverse human health effects," and "disproportionately high adverse environmental effects"; 2) identifying low-income and minority populations in the surrounding KSC community; 3) identifying the possible offsite environmental impacts; 4) identifying KSC's continued commitment to environmental justice; and 5) identifying and implementing action items which ensure that the goals of the EO and NASA's Environmental Justice Strategy are met. This section is based on KSC's Environmental Justice Plan, and updates data as available.

Between 1990 and 2000, the minority population within 60 miles of KSC nearly doubled, and by 2000, minority persons comprised nearly 30 percent of the residents in the area. "Hispanic or Latino" and "Black or African American" groups comprised approximately 86 percent of the potentially affected minority population in 2000. Blacks or African Americans are the most numerous resident minorities in the large area east of the City of Orlando. Due to the relatively large concentration of Hispanics or Latinos in Orlando, Hispanics or Latinos comprise the largest group of minority residents in the study area (NASA 2002c).

About 10 percent of the population of Brevard County reported incomes that were below the poverty threshold, with about 15 percent of persons below the age of 18 living below the poverty level (BPL) (Table 3-30; Table 3-31). Both figures are less than the State average. Three communities (City of Cocoa, City of Oak Hill, and Mims) have low-income populations above the State average. The City of Cocoa reported nearly one-quarter of its residents below the poverty level, more than twice the State average. The portion of the population living below poverty level in the three communities has not changed appreciably between 1989 and 1999 (latest available data; U.S. Census Bureau 2000).

Table 3-30. Percent of Populations Below the Poverty Level (BPL), 1999

Population	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	State of Florida
All persons[1]	9.7%	10.0%	11.7%	12.2%	8.0%	11.5%	12.4%
Persons under 18 years of age[2]	15.0%	17.3%	16.7%	17.9%	11.8%	17.9%	18.5%

Source: U.S. Census Bureau (2000), estimated 1999 income reported in the March 2000 Current Populations Survey.
[1] http://www.census.gov/hhes/www/saipe/stcty/a99_12.htm.
[2] http://www.census.gov/hhes/www/saipe/stcty/d99_12.htm.

Table 3-31. Percentage of Citizens by Poverty Level and Age, 1999

Place Name	Population (2000)	Total Poverty Level	% Total Below Poverty Level (BPL)	Related Children Under 18 Years	% Related Children Under 18 Years BPL	Total 65 Years and Over	% Total 65 Years and Over BPL
United States	281,421,906	33,899,812	12.4%	11,386,031	16.1%	3,287,774	9.9%
Florida	15,982,378	1,952,629	12.5%	607,607	17.2%	246,641	9.1%
Brevard County	476,230	44,218	9.5%	13,118	13.0%	6,003	6.5%
Cape Canaveral City	8,829	1,035	11.6%	270	28.7%	155	7.1%
Cocoa City	16,412	3,951	24.1%	1,623	38.7%	260	11.8%
Cocoa Beach City	12,482	812	8.5%	152	9.8%	171	4.0%
Melbourne	71,382	7,843	11.5%	2,130	15.4%	1,097	8.5%
Merritt Island CDP	36,090	3,334	9.4%	1,050	13.8%	478	7.0%
Mims CDP	9,147	1,408	15.6%	443	20.5%	199	12.4%
Oak Hill City	1,378	190	14.4%	79	25.0%	16	6.8%
Palm Bay	79,413	7,471	9.5%	2,361	11.5%	933	8.1%
Port St. John CDP	12,112	781	6.6%	262	7.9%	84	6.0%
Rockledge City	20,170	1,280	6.5%	296	6.2%	213	7.2%
Titusville City	40,670	4,932	12.4%	1,611	17.6%	533	6.8%

Source: U.S. Census Bureau (2000).

3.7.14 Transportation

3.7.14.1 Methodology

This section is based upon a Limited Impact Traffic Analysis performed by Motorist Design of Merritt Island, Inc. in April 2003 (Appendix J).

Methods used in the analysis were based upon standards outlined by the Florida Department of Transportation (FDOT) primarily in *Manual on Uniform Traffic Studies*, *2002 Quality/Level of Service Handbook*, *LOSPLAN 2002 Software*, and *Generalized Q/LOS Tables*, by the Federal Highway Administration (FHWA) primarily in *Manual on Uniform Traffic Control Devices Millennium Edition*, by the Transportation Research Board National Research Council's *Highway Capacity Manual Special Report 209*, and by the Institute of Transportation Engineers (ITE) primarily in *Trip Generation*, 6^{th} Edition, and *Trip Generation Handbook*, An ITE Proposed Recommended Practice.

3.7.14.2 Existing Transportation System

The traffic study area included roadways and intersections maintained and monitored by the FDOT and the Brevard County.

As the location of the alternative sites for the proposed are isolated quite a distance from urban areas, the roadways studied were limited to State Road (SR) 405 (SR 405, Columbia Boulevard, NASA Causeway, or NASA Parkway) and State Road 3 (SR 3, Courtenay Parkway or Kennedy Parkway). The existing interchange, at the intersection of SR 3 and SR 405, is within the restricted area of Kennedy Space Center. To a lesser extent, the proposed project will also impact US Highway 1 (SR 5).

In conjunction with the proposed ISRP, Space Commerce Way will allow unrestricted access between SR 405 and SR 3. The existing Visitor Center entrance would be relocated from direct access to SR 405 to Space Commerce Way.

Within the study area, SR 405 has been a protected corridor with the majority of the access points limited to right turn only with some allowing for left turns leaving the highway but prohibiting left turns from entering the highway. Restriction of left turns that allow access to SR 405 within the higher traffic areas have allow for efficient traffic circulation without significant degradation to the SR 405 corridor.

SR 3 has historically experienced more liberal access management than SR 405. Roadway travels longitudinally through an elongated island, side street traffic volumes throughout the study area were generally found to be minimal.

US 1 is the primary north south arterial through the Brevard County mainland. Connected to SR 405 via a full interchange, and currently accommodating fewer vehicles per day than it did during the space boom of the early 1970's, the impacted section of US1 was underused in the first part of the 21^{st} century.

Space Coast Area Transit System (SCATS) currently has more than 30 vanpools from various points to KSC and CCAFS. The number of scheduled routes has increased ten percent per year in recent years. SCATS authorities state that they would like to continue the recent growth rate, but that funding is not available.

The roadways and services levels for the potentially effected regions surrounding the proposed ISRP alternative locations (Figure 3-25) are described below.

SR 405: Within the study area, SR 405 is a limited access four-lane divided roadway with a current average daily traffic volume ranging between 14,000 trips west of US 1 and 25,500 trips east of US 1. The roadway is currently operating at level of service “B” throughout the corridor, based upon the FDOT generalized tables.

SR 3: A four-lane divided roadway, SR 3 currently accommodates between 16,100 average daily trips south of its intersection with Tropical Trail, on north Merritt Island, to 25,500 trips south of Hall Road, and to 32,000 north of the Barge Canal. The roadway currently operates at level of service “B” in the two north sections and level of service “C” in the south section, base upon the FDOT generalized tables.

Although the roadway link is operating at level of service “C” at the south end of the study section, existing turning movements at the intersections of the SR 528 ramps and SR 3 sometimes experience significant delays during peak periods.

US 1 (SR 5): Also a four-lane divided roadway, US 1 has an existing average daily traffic volume of 24,000 trips north of SR 405 and 27,000 south of SR 405. Along this rural section of highway, the arterial currently operates at level of service “B”, which is the best attainable level of service for a roadway of its classification.

During the space boom of the early 1970s, this same section of roadway actually accommodated 28,469 trips per day in 1973. Due to construction of alternate routes, improvements to existing routes and reduction of KSC traffic through the years, the study section of US 1 actually carries less traffic today. The roadway is currently underutilized.

SR 3 at SR 405: The existing intersection of SR 3 at SR 405 is designed as an interchange in order to maintain the integrity of east and west corridor. The interchange, however, is in an area that is restricted and does not always allow free access to the general public. The restricted nature of the interchange significantly hinders its viability as an evacuation route.

Space Commerce Way: The newly constructed roadway provides access for the general public between SR 3 and SR 405 from north Merritt Island to Titusville. This roadway is also planned to serve as a new primary entrance route to the Visitor Information Center and has been approved for widening by the State (NASA 2002a, b).

3.7.15 Public and Emergency Services

As proposed, the ISRP would be within a Municipal Service Zone, which would be designated under the authority of the FSA. The establishment of the Municipal Service Zone would allow the ISRPA, to enter into inter-local agreements for Public and Emergency Services (such as law enforcement and fire protection) with Brevard County, a neighboring municipality, or by contract with the NASA KSC provider. Public services for water and waste would be provided to the ISRP alternative sites from local municipalities, Brevard County, or KSC. Water from the City of Cocoa is available for consumptive use through existing force mains near the ISRP alternatives sites. For comparison, KSC uses an average of 4.9 million liters per day (1.3 million gallons per day (gpd)) with a maximum daily average usage of 8.3 million liters (2.2 million gallons). It obtains this resource under a service contract with the City of Cocoa, Florida, which provides for an estimated daily consumption of 9.4 million liters per day (2.5million gpd) and an estimated daily maximum of 14.1 million liters per day (3.75 million gpd). The Brevard County landfill would be a potential recipient of the solid waste through the county solid waste contractor.

Several options would be available for disposing of the sewage generated at the ISRP. The options include the Brevard County Sykes Creek Waste Treatment Facility or a treatment facility in the Industrial Areas on KSC. Each facility has the available capacity to handle the ISRP sewage.

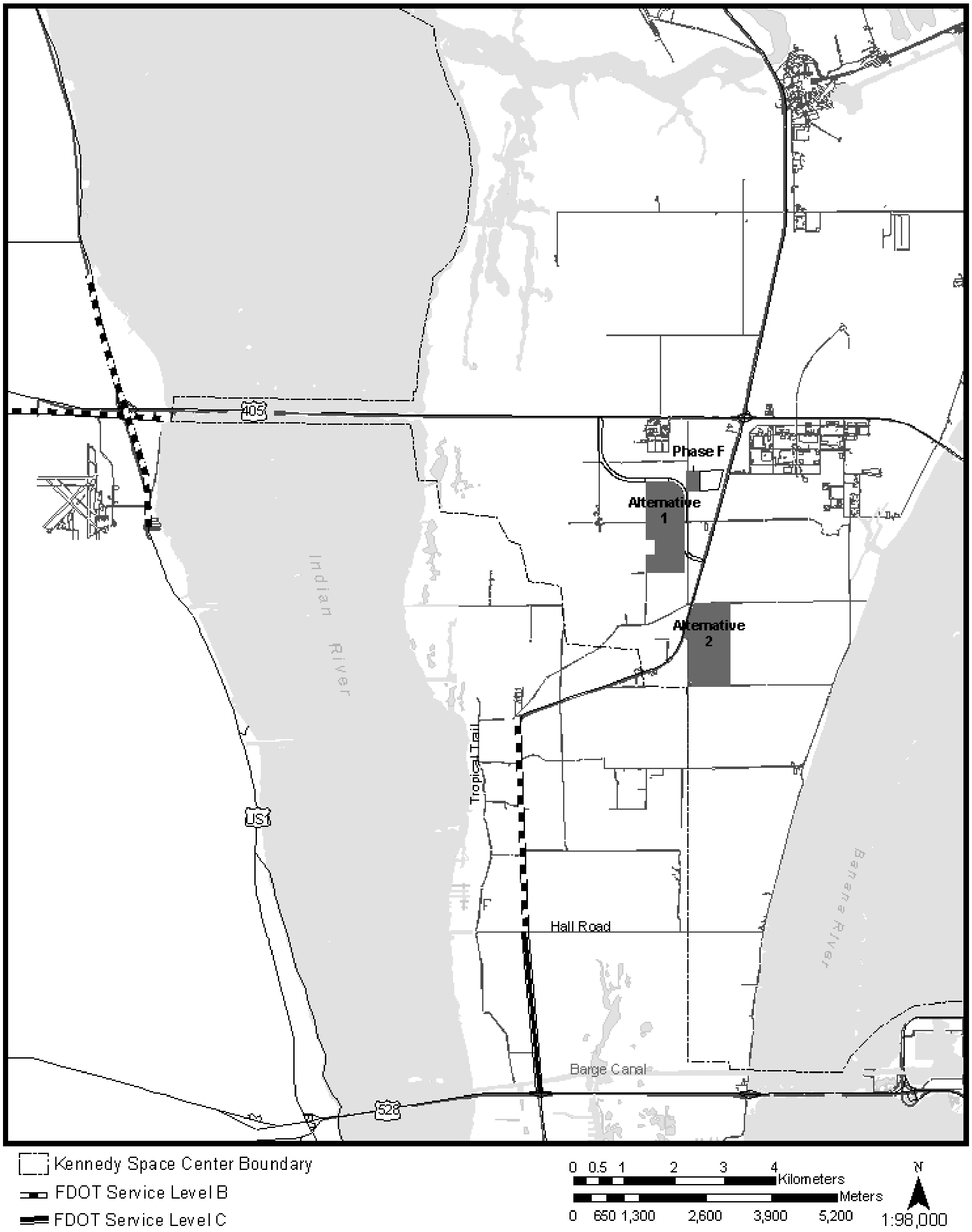

Figure 3-25. Roadways and Service Levels for Potentially Effected Regions Surrounding the Proposed ISRP Alternative Locations.

3.7.16 Recreation

KSC represents a blending of technology and nature at its best. KSC shares its property with the MINWR and CNS. Visitor opportunities at the KSC Visitors Complex, located about 1.6 km (1 mi) from the Alternative 1 (Phases A-E) site and Phase F and about 3.2 km (2 mi) from Alternative 2 (Phases A-E) site, abound. Visitors can learn how a Space Shuttle is processed and walk through a full-size model, tour the Rocket Garden, watch IMAX movies on the space program, take a bus tour to view KSC operational areas, and visit the Apollo/Saturn V Facility. Other nearby space-related attractions are the U.S. Air Force Space and Missile Museum located at the adjoining CCAFS and the U.S. Astronaut Hall of Fame, located about 6.4 km (4 mi) west of the Visitors Complex on NASA Causeway West (SR 405). The Valiant Air Command Warbird Museum, highlighting the exhibition of antique warplanes, is located approximately 3.2 km (2 mi) further west on Tico Road south of SR 405.

The IRL ecosystem in which KSC is embedded offers many nature-based recreational activities. The MINWR offers bird and wildlife viewing, hiking, fishing, canoeing, kayaking, and boating. The CNS protects the longest stretch of undeveloped beach on the east coast of Florida. It is open to the public for various beach-related recreational activities. The Brevard County Environmentally Endangered Lands (EEL) Program recently opened its first management and education center at the Enchanted Forest Sanctuary, located approximately 8 km (6 mi) west of the KSC Visitors Center Complex. The 364 ha (900 ac) Pine Island Conservation Area located less than 6.4 km (4 mi) from the ISRP alternative sites is a designated birding site along the Great Florida Birding Trail. The EEL Program and the SJRWMD manage the Pine Island Conservation Area.

Active recreational facilities at KSC, which are for NASA and contractor personnel only, include two gyms, a jogging workout trail, and two recreational parks that have tennis, basketball, racquetball, and camping facilities. The base facilities are within a 4.8 km (3 mi) radius from the ISRP alternative sites 1 and 2.

3.8 CULTURAL RESOURCES

Sites containing potential archeological or historical resources on KSC are protected under the National Historic Preservation Act (NHPA). Archaeological Consultants, Inc. (ACI) conducted an evaluation of these cultural resources in March 2003. The purpose of the Cultural Resources Assessment Survey (CRAS) (ACI 2003; Appendix K) investigation was to locate and identify any known cultural resources within the project area, and to assess their significance in terms of eligibility for listing in the National Register of Historical Places (NRHP). A comprehensive review of archaeological and historical literature, records, and other documents, and data pertaining to the proposed ISRP alternatives was conducted. The focus of this research was to ascertain the types of cultural resources known in the project area and vicinity, their temporal/cultural affiliations, site location information, and other relevant data. This research included a review of sites listed in the NRHP, the Florida Master Site File (FMSF), cultural resource survey reports, published books and articles, unpublished manuscripts, land and population records, maps, and interviews.

3.8.1 Archeological

A review of the FMSF revealed that no archaeological sites are currently recorded within Alternative 1 (Phases A-E), Alternative 2 (Phases A-E), or the Phase F site. Limited subsurface testing of two areas within Alternative 2 (Phases A-E), conducted during predictive model survey of the KSC South area, yielded negative results (ACI 2003; Appendix K). The closest recorded site to Alternative 2 (Phases A-E) is located about 2.74 km (1.7 mi) outside of the sites. Overall, seven archaeological sites are recorded within about three miles of the project area. These include two burial mounds, a 20th century artifact scatter, and four pre-contact period artifact scatters.

Predictive model surveys (ACI 2003) of KSC revealed a moderate probability zone located within the eastern part of the Alternative 2 (Phases A-E) site. Sites within this zone were characterized by relative relief, well-drained soils of the Pomello and Palm Beach types, and scrub oak vegetation, and were considered to have moderate to high site location potential. Areas characterized by level terrain and poorly to very poorly drained soil were considered to have low site location potential (ACI 2003). Alternative 1 (Phases A-E) and Phase F were both considered having low archeological site location potential.

Based on the patterns of aboriginal settlement, a potential for small artifact scatters on Alternative 2 (Phases A-E) existed. The potential for finding an archeological site of the pre-historic and historical period was considered to be very low. Archaeological field surveys of the proposed IRSP alternatives included both ground surface reconnaissance and limited systematic subsurface testing.

3.8.1.1 Alternative 1

Alternative 1 (Phases A-E) is characterized by level and poorly to very poorly drained soils, and was considered to have a low archaeological site location potential. At the time of survey, standing water covered much of this area, cultivated in citrus trees. Survey methods consisted of a thorough pedestrian surface with ground surface inspection. No subsurface shovel tests were excavated. No pre-contact period cultural materials were observed. Concrete rubble and an old pump tank were observed near a large live oak and patch of banana trees in the eastern portion of Alternative 1. This debris may be associated with a historic house which was once located in the vicinity (Jim Butts, personal communication, March 2003). The original house location, evident on the 1962 KSC Master Plan map (C-5), now sits under the recently constructed Space Commerce Way. According to tract book records, this land (southeast quarter of the southeast quarter of Section 1, Township 23 South, Range 36 East) was originally purchased in 1917 by Edward J. McGrath. No information about Mr. McGrath was found in the local histories (ACI 2003; Appendix K).

3.8.1.2 Alternative 2

Alternative 2 (Phases A-E), located east of SR 3 and south of Jerome Road, includes a well-drained elevated zone that was identified previously (ACI 1992) as a moderate probability area (ACI 2003; Appendix K). Archaeological field survey efforts were focused along the sandy ridge, vegetated with blue saw palmetto, scrub oak, smilax, gallberry, wax myrtle, and scattered longleaf pines. Survey methods included ground surface reconnaissance along firebreaks, trails, and other sandy exposures, as well as systematic subsurface testing. A total of 54 shovel tests were excavated along and proximate to the ridge. Of these, 30 were excavated at a 50 m (164 ft) interval, 22 at a 25 m (82 ft) interval, and two were placed at a 12.5 m (41 ft) interval. The stratigraphic profile revealed in the majority of shovel tests consisted of an upper zone of gray sand measuring approximately 20 cm (7.9 in) in thickness, underlain, to a depth of 1 m (3.3 ft), by light gray sand. No cultural materials were recovered from any of the shovel tests. However, one artifact was found on the ground surface. This find was recorded as a new archaeological site, and assigned the FMSF number 8BR1850.

3.8.1.3 Phase F

The Phase F parcel, which is environmentally similar to Alternative 1 (Phases A-E), also was considered to have a low site location potential. At the time of survey, this abandoned grove area was overgrown with elephant grass, Brazilian pepper, and Spanish needles. Six shovel tests were excavated throughout this property at a 50 m (164 ft) interval (ACI 2003; Appendix K) but no structures were located. Subsurface testing revealed an upper zone of black mucky humus, approximately 15 cm (5.9 in) in thickness, underlain by 20 cm (7.9 in) of gray limestone marl. Limestone bedrock was encountered at about 35 cm (13.8 in) below surface. No evidence of a structure located in the northwest comer of this area, as depicted on the 1962 KSC Master Plan map (C-5), was observed.

3.8.2 Historical

A review of the FMSF revealed that no historic structures were recorded previously within the proposed ISRP alternatives (ACI 2003; Appendix K). Examination of a 1936 Brevard County Highway Map, 1949 USGS quadrangle maps, and the KSC Master Plan Map C-5 indicated the former presence of a few structures within the project area. Specifically, the 1936 highway map depicts two structures in the southwest quarter of Section 6 (Phase F), due east of a road that ran along the section lines; and one structure to the west in the extreme northeast comer of Section 12 (Alternative 1 Phases A-E). A fourth structure was illustrated in the northeast quarter of Section 18 (Alternative 2 Phases A-E), due east of a road that ran north to south through the center of this section. Jerome Road was then named County Highway 70, and SR 3 was Highway 219. The 1949 USGS Orsino and Courtenay quadrangle maps depict two structures due east of Alternative 1 in the southeast quarter of Section 1, and one building in Section 6 (Phase F), on the other side of the old road. No improvements are indicated within Section 18. Finally, the 1962 aerial map (KSC Master Plan Map C5) indicated one due east of Alternative 1 (now Space Commerce Way), and a small structure in the extreme northwest comer of the Phase F parcel. No improvements were depicted within Alternative 2 (Phases A-E). However, two clusters of buildings were shown directly to the north, to the immediate northeast and northwest of the SR 3 and Jerome Road intersection. Examination of the 1976 quadrangle maps, as well as a ground surface reconnaissance, indicated that these structures are no longer extant. Presumably, these properties were either relocated or destroyed in the early 1960s (1962-1964) following acquisition by the Federal government.

The historical and architectural survey of the proposed ISRP alternatives revealed an absence of extant historic (pre-1953) resources within Alternative 1 (Phases A-E), Alternative 2 (Phases A-E), and the Phase F parcel.